DOCUMENT RESUME

ED 263 004 SE 046 219

AUTHOR	Meyer, G. Rex, Ed.; Rao, A. N., Ed.
TITLE	Teaching Science Out-of-School with Special Reference to Biology.
INSTITUTION	Asian Network for Biological Sciences.; International Union of Biological Sciences. Commission for Biological Education.
SPONS AGENCY	United Nations Educational, Scientific, and Cultural Organization, Paris (France).
REPORT NO	ISBN-0-85837-537-0
PUB DATE	84
NOTE	159p.
AVAILABLE FROM	Professor A. N. Rao, Secretary, ANBS, Botany Dept., National Univ. of Singapore, Lower Kent Ridge Road, Singapore 0511 ($5.00).
PUB TYPE	Collected Works - Conference Proceedings (021) -- Reports - Descriptive (141)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Biology; Concept Formation; Educational Trends; Elementary Secondary Education; *Environmental Education; *Field Instruction; Field Trips; Foreign Countries; Higher Education; *Outdoor Activities; Outdoor Education; *Science Activities; *Science Education; Science Programs; Teachers; Zoos
IDENTIFIERS	*Out of School Programs; Singapore

ABSTRACT

This book contains a selection of previously unpublished papers from an international Asian symposium on out-of-school science activities. These papers include: "Educational and Social Values of Out-of-School Science" (Peter Kelly); "School Versus Out-of-School: An Artificial Dichotomy" (William Mayer); "Biology of Leisure" (A. Rao); "Influences of Out-of-school Activities on Concept Formation in Science" (Gerhard Schaefer); "Problems and Prospects of Popularising Science and Technology Through Non-school Activities--Some Thoughts on the African Situation" (Michael Atchia); and "The Continuing Professional Development of School Teachers for Out-of-school Science Activities" (G. Rex Meyer). The volume also includes papers addressing regional trends and case studies: "Development of Out-of-school activities in Science Education in Jordan" (Elias Baydoun); "A Checklist of Out-of-school Science Activities in Kuwait" (M. Subbarini and A. Kablaoui); "Out-of-school Science Activities in Malaysia" (Cheong Siew Yoong); "Field Trips and School Camps--Developments in British Columbia" (Fred Gornall); "Out-of-school Activities in Japan for Primary and Secondary schools" (Kozo Imahori); "Out-of-school Science Activities--Retrospect and Prospects in the Caribbean" (Winston King); "Out-of-school Science Activities in the Federal Republic of Germany--An Historical Note" (Gerhard Schaefer); and five papers on out-of-school biology activities in Singapore. The conclusion contains the paper "The Place of Out-of-school Science in General Education--Current Trends and Future Prospects" (G. Rex Meyer). (JN)

TEACHING SCIENCE OUT-OF-SCHOOL

WITH SPECIAL REFERENCE TO BIOLOGY

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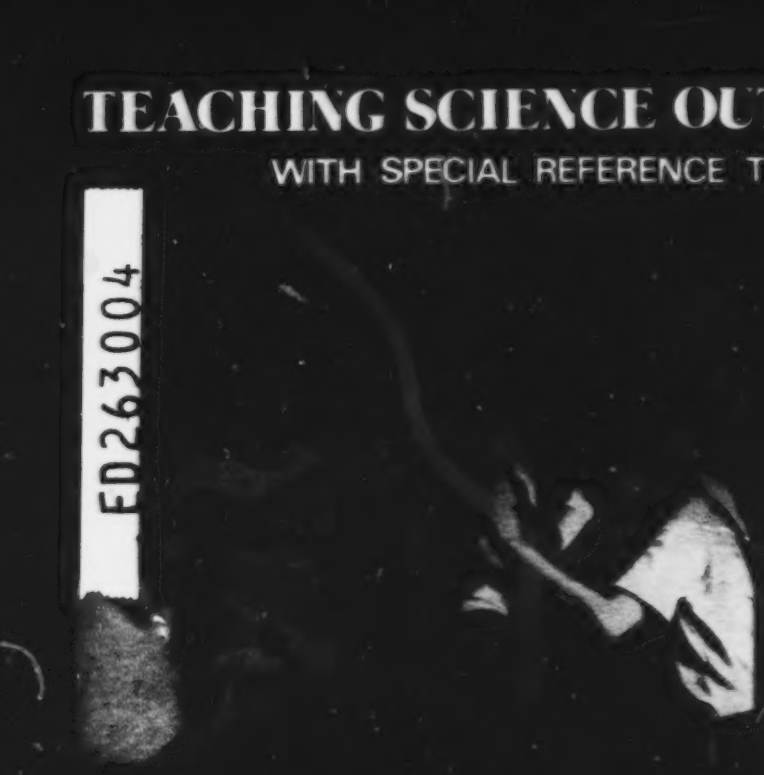

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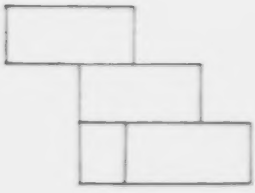

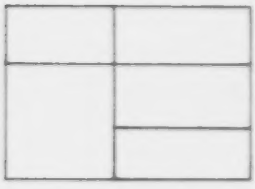

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ACKNOWLEDGEMENTS

The Division of Higher Education and Research, and of Science, Technical and Vocational Education of UNESCO have both encouraged and generously supported the work of the IUBS Commission for Biological Education.

This publication was supported by a grant from the Division of Higher Education and Research of UNESCO.

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
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and

ASIAN NETWORK FOR BIOLOGICAL SCIENCES

TEACHING SCIENCE OUT-OF-SCHOOL

WITH SPECIAL REFERENCE TO BIOLOGY

Edited by

G. Rex Meyer
School of Education
Macquarie University, Sydney

and

A.N. Rao
Department of Botany
National University of Singapore

International Union of Biological Sciences
Commission for Biological Education
and
Asian Network for Biological Sciences
Singapore and Sydney
1984

TEACHING SCIENCE OUT-OF-SCHOOL

Edited by G. Rex Meyer and A. N. Rao

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International Standard Book Number ISBN 0 85837 537 0

Printed in Singapore.

Cover design by Editors.

First Edition July 1984.

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ACKNOWLEDGEMENTS

Special acknowledgement is made of contributions by Unesco in providing financial and organizational support for the original Symposium on *Out-of-School Science* held in Singapore, 3-7 June 1981 which forms the basis for this book and for their continued support for activities of the *International Union of Biological Sciences Commission on Biological Education.*

Thanks are also due to the *Science Teachers' Association of Singapore* and the *International Council of Associations for Science Education* for inviting some of the Commission members to be the main speakers at the international symposium organised by them.

The Executive
IUBS-CBE

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PREFACE

From the Third to the Seventh of June 1981 in Singapore, the *Commission for Biological Education* of the *International Union of Biological Sciences* (IUBS – CBE) co-operated with the *Science Teachers' Association of Singapore* (STAS) and the *International Council of Associations for Science Education* (ICASE) in presenting an international Asian symposium on OUT-OF-SCHOOL SCIENCE ACTIVITIES.

In 1982, a selection of papers presented at the Singapore Symposium appeared in a booklet of *Proceedings* published by STAS and ICASE. That publication, however, was unable to include all papers prepared and presented at the meeting by IUBS-CBE. It also had a limited distribution, being largely restricted to symposium participants. In 1983, therefore, IUBS-CBE decided to produce this present volume to complement the *Proceedings* and to enable publication of IUBS-CBE contributions not previously published, to up-date papers by IUBS-CBE members that were included in the original *Proceedings* and to commission new papers to give the book a global emphasis.

The present book is organized in four parts. The first consists of an introductory discussion by Professor Peter Kelly, Chairman of IUBS-CBE at the time of the Singapore Conference. The Second Part contains five papers on general issues by Meyer, Schaefer, Rao, Atchia and Meyer. The Third Part reviews trends and case studies from areas of the world as diverse as Africa, Arab States, Canada, The Carribbean, Europe, Japan, Malaysia and Singapore and provides a useful resource for comparative analysis. Part Four presents an analytical review by Meyer of past, present and future trends in the area of out-of-school science.

G. Rex Meyer
A. N. Rao
December 1983

ONE

INTRODUCTION

1. EDUCATIONAL AND SOCIAL VALUES OF OUT-OF-SCHOOL SCIENCE

Peter J. Kelly
Chairman
IUBS Commission for Biological Education
Department of Education
The University
Southampton S09 5NH
UK

Out-of-school science activities – field trips, visits to museums, studies of industry and the like – are, not infrequently, perceived in the same light as virtue. They are assumed to be inherently good. The question we ask of them is *how* can they be undertaken. We rarely ask *why* should they be undertaken or by which criteria their value can be assessed.

This, I must confess, is my usual disposition on the matter. That is, until recently when I talked to one of my daughters about an industrial visit she had been on with her school. What did she remember about it? What interested her? Well, there was the fun with her fellow pupils she had on the bus; the ice-creams she had eaten; and the things she saw but found it difficult to describe. She filled out a worksheet and was highly impressed by the man showing them around, who remarked that the visit was obviously much more interesting than anything they did at school.

All in all, I got the impression of an illusion. The excursion had been interesting but for the wrong reasons. There was a lot seen but little learned. What appeared to integrate school work with the outside world had resulted in increasing the distinction. Obviously one could query the methods used or my daughter's motivation and abilities but, above all, the event seemed to me to beg the questions of what value was it, and of what value could it be. These are questions about 'why?' rather than 'how?' and about our motivations for doing things. They are the primary questions one must ask to ensure that educational activities can be made relevant.

There is currently a growing interest in the development of out-of-school science activities; hence the symposium. However, the idea is not new. It is just we are emphasising it much more. Why is this so? I would like to hazard a guess at a few reasons.

The first results from what I call the reactive nature of educational thought. Following a burst of new ideas in one direction there is invariably a swing to another. In the last decade or so science education has become satiated with ideas for new practices and new materials for schools. The scope for thinking up really new ideas for schools has declined and thus innovators must look elsewhere: that, of course, must be out of school. Although this comment may sound somewhat cynical, I feel there is truth in it and we need to heed it. We need to be aware that as a result of this reactive process ideas arise not necessarily because they are relevant. They can arise merely to satisfy the needs of active minds.

A second reason probably arises from the frustration of innovators and those who wish to see schools responding more quickly and effectively to change. It also arises from

the recognition that there are limits to what schools can reasonably be expected to accomplish. Agencies outside the schools are seen as a means of overcoming their limitations. At first thought this all sounds commendable, but a moment's pause enables one to realise that such ideas can, in practice, lead to work in schools being undermined and, particularly when money is short, to resources being diverted from them.

Thus we have examples of two forms of motivation which, whilst apparently virtuous, can worsen rather than improve matters.

Another reason people have for undertaking out-of-school science activities is that they are seen as a means of augmenting the science curriculum of a school, by providing facilities and opportunities unobtainable within a school; by enhancing the motivation of pupils in a way that can benefit their school work; and by supplementing and illustrating topics studied in school.

The final reason I wish to cite (whilst recognising that there are others I could have mentioned) is that which conceives out-of-school science activities as a means of introducing pupils to the applications and implications of science.

The idea that science education should be related to society and/or emphasis put on its practical use is by no means new. Indeed, in some countries, such as the U.S.A., it was a significant feature of their science teaching until the last two or so decades when there has been a move away from it and new courses depicting science as the work of scientists were introduced. In countries like Britain you have had a dichotomy of thinking over many years. Courses for able pupils, and particularly those likely to become scientists, emphasised concepts and the procedures used by scientists in their work. It was in courses for the less able or non-scientific pupils that you found the greatest reference to the applications and social implications of science.

In most of our countries there has been a long history of antagonism between what we can call the 'science for scientists' and the 'science in society' approaches. The differences rather than the similarities in the approaches are to be emphasised and opposing images have been built up. According to preference and interpretation the *science of scientists* either has 'the excitement of discovery' or is 'merely learning facts'; *science in society* is either, for example, a 'soft option' or 'an experience in relevant decision-making'.

At this time I suspect that the balance of opinion is probably behind or, at least, leaning towards the science in society approach in many countries. However, I equally suspect that the balance of practice is with the science of scientists approach and, in that framework, of a descriptive rather than an enquiring kind.

Personally, I think that science education should incorporate both approaches. However, it is the current interest in the science in society approach which is relevant to our present discussion because it is easily linked to the idea of out-of-school science activities. Through, for example, visits to industry the technological dimensions of science education can be realistically illustrated, and through fieldwork environmental considerations can be given reality.

The two reasons I have just outlined – in which out-of-school science activities are seen as ways of augmenting the school curriculum and supporting a 'science in society' approach seem to me to be of a different order from the first two I mentioned and of considerably greater merit. They focus on the content of out-of-school science activities not just the event itself. They unite rather than separate activities in school and out of school.

The values of educational activities are derived fundamentally from the motivation (the reasons) for undertaking them. By contrasting the two pairs of reasons for out-of-

school science activities I have attempted to illustrate this dictum and, hopefully, to demonstrate the necessity for a careful examination of our motives before we proceed too far with programmes of out-fo-school science activities. Innovation and enthusiasm *can* be of value but without relevant reasons they can be valueless and even counter-productive.

Lest what I have said so far sounds too negative (although I do not intend this and have merely made a plea for caution) let me take on the task of trying to establish a positive framework for programmes of out-of-school science activities. The one I would like to suggest to you takes the form of three criteria against which the value of a programme of out-of-school science activities can be assessed.

1. That the distinctive nature and roles of in-school and out-of-school activities are utilised in a co-ordinated manner.
2. That major social and personal needs of the future are satisfied.
3. That pupils are prepared for active participation in the life of their community both as young people and adults.

In-school and out-of-school

Whilst it is commonly considered that learning, exploratory behaviour (inquiry) and interest are closely related there is, in fact, little evidence that this is necessarily so. Literally hundreds of studies have been undertaken in which achievement (= learning) has been correlated with interest. Rarely do we find a high correlation. From our classroom experience we recollect pupils who asked the most searching questions and displayed considerable enthusiasm in lessons but, unfortunately were unable to demonstrate subsequently that they had learned much. I am not, of course, suggesting that if you are interested and enthusiastic about a subject you will not be able to learn it. Obviously it is possible, but you cannot count on it. Learning can be helped by explanation and motivation but it is a distinct phenomenon and its achievement arises from its own characteristics.

Schools, I suggest, are essentially places which provide the opportunity for intense, conscious and systematic learning. They are also institutions of socialization, as is the family, for example; but whilst some of this socialization occurs through the influence of the teachers on the pupils (rather like the influence of parents on their children) it occurs more intensely within peer groups of pupils. Both these features of schools need to be taken into account when developing out-of-school science activities.

When planning out-of-school activities it is important to link them to the more structured learning activities within the school. An emphasis can be put on inquiry and creating interest in pupils but this needs to be connected, both in preparation before an activity and in synthesis afterwards, to discernible conceptual structures learned by pupils in the school.

Another variation of this distinction is between what may be termed knowledge and issue studies. The former is based more on structured learning, the latter more on diffuse inquiry, although there is overlap. To illustrate the difference, let me refer to some simple experiments with plants.

If you obtain some exhaust gas from a car in a polythene bag, put in a plant and leave it for a while, the leaves will fall from the plant. You can set up control experiments, one with no exhaust gas (only normal air) and one with exhaust gas plus some potassium permanganate. Plants under these conditions will retain their leaves. It is, in fact, ethylene in the exhaust gas – which can be removed by potassium permanganate – which causes the leaves to fall from a plant.

This experiment is essentially a knowledge study. It involves the systematic and structured pursuit of knowledge.

We can also perform the experiment using three or four apples instead of exhaust gas and similar results will be obtained. Apples produce some ethylene. Again this would be termed a knowledge study.

However, if we now put the findings of the two experiments together and consider their social significance, we have an issue study. What should we do about ethylene pollution? If we legislate against having ethylene in petrol should we also legislate against apples being sold? (Incidentally, there is no need to worry, apples will not hurt you.) Such questions require decision-making, not just structured learning. Opinions as well as information are involved and the answers are less certain.

To undertake such an "issue" study out-of-school would clearly be of value. Measurements of ethylene content in streets could be undertaken. People's opinions could be obtained. Economic aspects could be looked into.

Such issue studies based on knowledge studies in school make valuable out-of-school science activities. They utilise the mutually beneficial values of systematic school learning and the more diffuse data-gathering and inquiry of the out-of-school activity. They enhance the activities and values of the school.

Some years ago I took part in a study of two groups of youngsters in a botanical garden. One was a group of seven and eight year olds, the other of thirteen and fourteen year olds. We observed their behaviour as they studied the habitats in the garden. There were some interesting contrasts.

The younger group used their five senses, smelling, tasting, listening to and feeling objects, not just looking at them as did the older children. The younger group behaved as individuals and thought up their own ideas – right and wrong. Children in the older group were concerned about the reaction of their peers to any ideas they might have and they continually referred to books for authority.

This simple study demonstrated the influence of socialization on children growing up. It tends to result in perceptions limited to those of sight, and dictated by the norms of the peer group and the authority of the written word.

This limiting effect is greatest within school. Out-of-school science activities can be used to counter this by encouraging the use of a range of senses, individual work and resource to the authority of personal and direct experience.

I do not wish to contrast science activities in school and out of school too severely. Clearly, for example, some issue studies can be undertaken in school and some structured learning can occur through out-of-school activities. However, the two arenas do tend to favour the achievement of different types of educational aims and this we ought to exploit through programmes of co-ordinated in-school and out-of-school activities.

Social and personal needs of the future

The old Chinese saying by Kwan-Tzu tells us –

When planning for a year –
sow corn.

When planning for a decade –
plant trees.

When planning for life –
train and educate men!

There is considerable, if not, total truth in this statement. From our schooling we receive much of the knowledge, understanding and other influences which, in many ways, clearly and subtly determine the path of our adult lives. The future, then must be a major concern of those in education.

It is sometimes said that the only thing certain about the future is its uncertainty. This is not an unreasonable view. It points to the necessity of education being a combination of activities which, on the one hand, provide the confidence of basic understanding and fundamental values and, on the other, develop the skills and attitudes for innovation and for adapting to change. Such an approach is essential but, I suggest, incomplete. To some extent we must attempt to anticipate change.

Within our societies today are the seeds of possible future developments. Some will grow, others will wither. Science and Technology, of course, provide the soil in which many of these seeds are germinating. Young people need to be aware of these processes. It is important also to identify the developments which are likely to thrive so that our pupils can be prepared for them.

Out-of-school science activities can play a major role in enabling youngsters to become aware of possible futures. To do so the emphasis should be on discovery and invention rather than past achievement. A visit to a traditional museum can provide an illustration of the process of change and, of course, has cultural value. A visit to a research establishment, an industrial development unit, or a 'discovery' science centre or museum, on the other hand, can provide examples of what may be important in the future; and this, I suggest, is of superior value. Note for example the special contributions made by the Singapore Science Centre described in Part Three.

It is possible to prophesy some future trends with reasonable – if not absolute – confidence and, when these relate to important social and personal needs of our pupils, I suggest they should be given priority in programmes of out-of-school science activities.

In the field of technology, for example, we can be reasonably certain that communication technology (based on micro-electronic systems) and biological technology (including genetic engineering, the increased use of living organisms for the industrial production of chemicals and other materials, the use of artificial organs and tissues in medicine, and the development of mixed living and artificial systems) will be sufficiently important aspects of our lives in the coming decades that all citizens – not just specialists will need to know about them and appreciate the social, legal and moral implications they engender.

There is a story about a busy professor who, knowing he was unable to give a lecture himself, left a tape recording of it for his students. On returning somewhat earlier than he expected he found no students but a class of tape recorders switched to record! I suspect that in the not-too-distant future the fantasy of that story will be uncomfortably near reality. I suspect also, that the idea of *Homo sapiens* evolving into *Homo machinus* will not be one we can dismiss lightly.

We can take another example of confident prophesy from medicine. The enormous advances of medical research have ensured that we have the knowledge to control the greater part of human illness, given adequate resources. In the case of less developed countries where control of infectious disease and malnutrition are major concerns the effective problems are mainly economical, political and those of personal behaviour. In many developed countries the problems are almost entirely those of social control and personal behaviour. Accidents, smoking, ill-balanced diets and environmental pollution are examples of modern epidemics.

For many countries in the future, the way individuals behave will be crucial in maintaining a healthy society. This is an educational problem and one that requires people

to be aware of their personal health needs and their responsibility to maintain their own health. It also requires that through education we provide people with the resources of knowledge and attitudes that will enable them to contend with those social influences which foster ill-health. It will be important to include in a young person's education activities concerned, for example, with decision-making related to health matters, studies of environmental factors affecting health, of the influence of drugs, and of the role of exercise and diet in developing fitness, and also activities involving the critical appraisal of advertisements and other forms of communication related to health. With all such topics a pupil's understanding would clearly be enhanced if out-of-school science activitives were involved.

I have cited the cases of technology and health purely as examples of topics for which future trends are discernible and the educational value of out-of-school science activities is relevant. They are topics which relate to social and personal needs of importance to the pupils' futures. I suggest that our choice of which out-of-school science activities we undertake should depend on such criteria being satisfied.

Preparation for community life

So far we have looked at the idea of education being a preparation for the future from the perspective of the intellectual development of our pupils. We have put emphasis on the provision of the knowledge, skills and attitudes which will enable them to compete with the kind of society we expect them to grow into. We can extend this by considering how we might prepare young people for contributing to, and participating in, the community they will live in.

In terms of science and technology education there are two aspects to this matter. In the first place we can use out-of-school science activities to stimulate younger people to enter the scientific and technological professions. Of equal importance is the need to provide an experience which will encourage the majority of our pupils who will not enter these vocations to continue with an active interest in science and technology in their adult life. By developing the practices of reading newspapers and journals, looking at television and listening to radio in order to keep up-to-date in scientific matters and the implications of them to society; by encouraging young people to join clubs and societies concerned with science and technology; and by informing them of the variety of agencies in the community concerned with the subjects and providing them with experience of them; then we are at least attempting to inculcate habits of being aware of science and technology and of community affairs relating to them.

Let me finish on that point, for I feel it is the most important. If you asked me what should be the major aim of out-of-school science activities my answer would clearly be 'to produce a society enlightened about the nature of science, knowledgeable about its major ideas, with understanding about its technological value and its social and personal implications, and actively committed to the idea that the affairs of science are inextricably entwined with those of society'.

TWO

GENERAL ISSUES

2. SCHOOL VERSUS OUT-OF-SCHOOL — AN ARTIFICIAL DICHOTOMY

William V. Mayer
Former Director
Biological Sciences Curriculum Study
P O Box 930, Boulder
Colorado Springs, CO 80306
USA

While we like to think of the school as the prime source of a student's education, it becomes quite apparent that the school is almost an isolated entity in the lives of students. The dichotomy between the home, community and social life of the student, and the school is reinforced, in many cases, by the school not relating to the world outside its boundaries. It becomes a sterile, intellectual environment in which the student is handed isolated pieces of knowledge within an antiseptic and non-relevant framework which bears about the same relationship to the real world as does a hospital operating room and for about the same reasons.

Perceptions of schooling

Frequently, students describe their world of friends, home, family, community, work, play in one way and the school as a separate, isolated entity that does not apparently tie into any of the students' communal perceptions. Thus, the student looks upon his home and community, the world of play and work, as a real world and the school as an intellectual, but unreal, world. It is not difficult for a student to perceive the need of a facility with written and spoken language, the ability to read and to become familiar with mathematical manipulations and, if the student has career goals, he may recognize the validity of certain information in leading him toward the realization of these goals. In these instances, the school has relevance.

The mere fact that this book bears the title "Out-of-School Science Activities" reinforces the existence of this dichotomy, for we ourselves think in terms of in-school and out-of-school. So, from our side of the fence, the school becomes the real world and the surrounding community unreal and, in some cases, unsympathetic to the goals of education. I submit that the in-school/out-of-school dichotomy is one that we create and inadvertently foster, and that our attempts to build bridges between town and gown and the classroom and the community are few and far between, and not really successful. There should be no boundary between the school and the environment in which its pupils live. The ideal would be a community and a school working together to provide students the experiential base necessary to realize their own potential and to contribute to societal objectives.

However, with few exceptions, societal objectives are not clear. They change, they are contradictory, they may be illusory and platitudinous, but almost all would agree that societies that allow their citizens to achieve their innate potentials, from which want and poverty are banished, are certainly a desideratum. Conversely, many times our educational goals are no clearer than our societal ones, and this mutual confusion may

give us more in common between school and community than if each had clear objectives that were patently non-congruent.

Schools frequently critize society for lack of standards, for pondering to the lowest common denominator, for offering bread and circuses, and for fostering visceral rather than intellectual reaction. Communities criticize schools because they are perceived as elitist and critical, and that they have failed to inculcate into the students what neither the community nor the family has been able to accomplish. Each, in many cases, blames the other for the deficiencies of its end product, namely, the citizenry. Citizens with poor taste, poor skills, and poor intellectual resources are blamed on the schools, while poverty, malnutrition, litigation, contention and war are blamed on the community, but these are not separate, identifiable, isolated instances. We all live with a foot in each camp, one foot in rational education, the other in the realities of life. The perceived walls between these two camps need to be broken down. There have been attempts to do so. The concept of life-long learning, the return of populations formerly thought beyond school age to the educational fold, and the increase in mass communication indicate that the dichotomy between in-school/out-of-school may no longer be a valid separation.

Two-way interaction between school and society

In the process of getting older we get wiser, whether in school or out of school. Our formal in-school education is only a part of what makes us who we are and what we are. Each of us has been moulded by a wide variety of in-school and out-of-school influences. In my day, the motion picture taught as much or more than schools about social graces, societal problems, achievement potential, and the world in which we lived, and it did so in a meaningful and exciting way. Today, television is a much more ubiquitous device to bring us news and entertainment, to reflect or distort our society, to focus on problems, and to provide role models. Movies and television, radio and audio cassettes, magazines, newspapers, and books, all influence society and are essentially out-of-school resources, many of which schools ignore and some of which we deprecate. How often are lead stories in newspapers, for example, used as take-off points for a classroom lesson? How frequently does a bit of classroom information become useful to a student who is directed to its application in society? This is a somewhat different question than asking how may societal components reinforce the classroom. Out-of-school science is a two-way street. It is the school extending into the daily life of the student and the daily life of the student becoming involved in classroom activities. If the school desires the community to reinforce its role there is a *quid pro quo* that the community demand of the school that it reinforce societal values and contribute an education of practical as well as ethereal values. If we talk about out-of-school science, then we need also to talk about in-school, community concerns.

We hear frequent mention of science clubs, pre-school science activities, science fairs, field trips and science camps, and the use of local organizations. We do not hear so much about how schools can use other community resources. By this I am not talking of zoos and museums, science centres or visits to industry, of which schools already avail themselves, but of more common and even less used resources. For example, how many science classes co-ordinate with commercial TV programmes? By this I do not mean programmes specifically directed to schools, but programmes that attempt to explain science to a lay audience. Programmes such as these usually fall between chairs because they are attempting to do, in a public setting, what schools do badly in a private setting, and that is to synthesize a wide variety of material.

Attempts at synthesis

Unfortunately, it is easier to teach detail than to synthesize detail, for synthesis

involves the formation of useful conclusions and concepts bereft of the surrounding clutter of extraneous detail. The student must be brought to view the synthesis as a pristine tree standing alone on a prairie and not as a tree in a tropical forest, obscured by underbush, clinging vines and surrounding trees to the point where the appreciation of the concept "tree" is lost in a mad welter of intertwined green species.

An unfortunate attempt to present a synthesis has been manifest in the so-called "team-teaching" approach not at all uncommon in secondary schools and colleges of the United States, where so-called "survey" courses involve specialized presentations by a number of discipline-oriented practitioners with the students left to synthesize history and art and music and politics as well as science and technology. It has taken quite a while, but many of our colleges and universities have awakened to the fact that if the faculty itself is not competent to prepare a synthesis, how then can we ask an untutored student to do so? Team-teaching is now getting a bad name by expecting students to provide the expertise lacking in the faculty, and many of these courses have been discontinued for just that reason. Who does the synthesis? Who is trained? The answer: almost no one. Actually, the best synthetic approaches to science have not been in the classroom but on public television: the intricate expertise of a Jacob Bronowsky as he discusses the *Ascent of Man*, the hyperpoetic and narcissistic presentations of Carl Sagan as he explains the *Cosmos*, or the interesting leap-frogging between disconnected events exemplified by James Burke in the programme *Connections*. These are synthesizers: good, bad or indifferent, they are making the effort to reach a scientifically uninformed public, which schools need to emulate. They constitute an out-of-school resource in science to which students should be referred and about which discussions in school should be undertaken. We see nothing wrong in assigning the student outside reading. There is nothing wrong also with assigning the student out-of-school viewing, and there are many programmes that are either so good that the student cannot help but learn something from them or so bad that a discussion of them is valuable concerning the development of a critical mind to distinguish gold from fool's gold.

Science and Society

If television is to be brought into the classroom as an out-of-school activity, what can the student take from such an activity that is likely to be valued and valuable in the societies of the future? As citizens increasingly need to understand science and technology in order to make informed choices that concern their own futures, curriculum design must reflect current involvements of science and technology in society. What are societal objectives for such problems as pollution, health, energy, nutrition and population? If an objective of science education is the development of skills and values that promote the use of knowledge that is both wise and insightful, our education in science must be based on reliable knowledge and identifiable societal goals.

The target population, its needs and objectives to meet them, form a chicken/egg circle. Science provides us with data on problems but does not tell us what we ought to do about them. Science, as a discipline, neither defines nor imposes values, but it creates problems and issues that require moral and ethical judgements. The compartmentalization of science in a value-free context can no longer be sustained. We can no longer concentrate on fact while ignoring purpose. The social implications of science must be dealt with. If not deliberately and intelligently inculcated, they will nonetheless be developed through an expensive, and perhaps fatal, trial-and-error methodology. Decision-making as a goal of science teaching must have a high priority, but by dealing with the so-called "soft" sciences we tread on toes and create controversy, the first of which, of course, is the controversy about whether we should deal with controversial topics. Every one of us is bombarded by television, radio, newspapers, magazines, and every conceivable

source, with information that clearly illustrates we are in a contentious and litigious societal framework. The safe thing to do is to retreat and deal with nothing contentious. The parts of a flower, the names of the chemical elements, the planets in order from the sun, and Newtonian mechanics are examples of non-controversial materials that give the appearance of education without eliciting negative comment. It is sad to think that much of our curriculum is a vast educational placebo, producing no ill effects but providing not much more than psychological support.

The danger of over-simplification

Pressures to produce results, such as the "publish-or-perish" tradition of many universities, have led to trivialization of the literature of science as much as it has for the literature of society. When the public reads in *Time* magazine, for example, that educational theorists have just discovered a high correlation between time spent on task and favourable results, they are unimpressed when the conclusion, reduced to its simplest state, is a recapitulation of the obvious, namely, that when students work at reading and writing, they get better at them. Other educational research has underwhelmed us with such revolutionary information as that well-educated, experienced teachers produce more successful students than do badly educated, inexperienced teachers. Discoveries of this nature are unlikely to impress society with the aims, objectives or abilities of professional educators.

In the realm of science, we are informed about what we already know with such earth-shaking conclusions as that people with good nutrition live longer and that rising temperatures make people irritable. Knowledge that any peasant instinctively possesses now arrives at our front door in a burst of light, like revelation. We have either forgotten or ignored centuries-old information that can prove valuable to our society and its citizenry. For example, a doctor who opened a free clinic for hippies in the Haight-Asbury district of San Francisco during the 1960s discovered his patients had developed infections, sores, and other maladies not seen by medicine since the 13th century. The "flower children" had simply unlearned centuries of civilization's experience in the field of hygiene. As Lance Morrow notes in his *Time* article, in their bedding, clothing and grooming they had reverted to a state of nature that Rousseau never imagined. It took time to group and painfully reformulate the basic rules of body maintenance and to reinvent the use of soap and water.

The use of out-of-school resources such as magazines is a common practice, but how uncritically do we accept what we read? There is a necessity for looking behind the data. So many special-interest groups are monomaniacally dedicated to the pursuit of one cause that they are frequently guilty of skewing their data to support the conclusion they feel so valuable. Conclusions and statistical analyses need be approached with a healthy skepticism when identified as the product of special-interest groups. Disraeli stated that there are three kinds of lies: lies, damned lies, and statistics.

As an example of an out-of-school resource that needs in-school analysis, I refer you to *Natural History* for January, 1981. It reports on the ecology movement in the United States after ten years and, from the data tables presented, one is led to believe that there have been strong, positive effects of the movement. The data analysis which matched movements in 1980 and attitudes toward them drew the conclusions that, of all the activist movements described, the environmental movement contained the most followers, but this was only true for activists. Far more people were favourable or agreed with the goals of social justice than those for environmental protection. Cultural attitudes toward the environment were seen to change as follows: a few more apparently agree that technology can solve environmental problems, fewer disagree that private property owners have certain rights. The profit motive seems to be more highly thought of, the

faith in the political and economic system seem hardly to have changed. Fewer seem to be concerned with population growth, more feel economic growth is good, and there seems to be a decided increase in the support for individual responsibility.

These are both interesting and, in some measures, satisfying statistics, but it would be disastrous for a political/social/economic system to use them as a basis for action. First of all, the questionnaire was published in *Natural History* magazine, distributed to an already pre-polarized and selected societal population, with a declared interest in nature. The comparative figures between 1970 and 1980 are quite suspect in that only 7% of those who responded to the 1980 questionnaire remembered filling out the 1970 questionnaire, so that the changes may not be so much due to changes within individuals as with change of individuals sampled. The 1980 sample consists of about 4,000 respondents, who must be regarded as a selected population of a selected population, with enough interest in, or anger about, the situation to respond.

When one looks at the composition of the sample responding, we see it is preponderantly over 30 years of age, female, most with graduate training or advanced degrees, skewed toward high annual income, largely professional, and education or social service in occupation. While I fully expect to see these results widely broadcast, I do not expect that the results will be accompanied in newspapers, magazines or on television by an analysis of the population responding. Instead, the extrapolations normally made will be that people in general respond in this wise. Using articles such as this as an out-of-school resource we might be able to teach our students something about statistical analysis or at least to insure that they look behind the data as to how many responded, who they were, what was their initial polarization, as well as who did the analysis and what was their initial bias. By using such out-of-school resources as provided by these data, we might convince students to beware of statistics used as a drunken man uses lamp posts – for support rather than illumination.

The gap between promise and fulfilment

One of our problems is failure to implement objectives or reach goals. There is a marked difference between promise and fulfilment. Most teachers, when listing objective for education, as in a study that appeared in the Janaury, 1981 issue of the *American Biology Teacher*, have at least somewhere in their top five objectives, teaching the students to think and reason and teaching them how to learn on their own. However, investigation of classrooms indicates the emphasis is still on detail, on what Bloom has called 'Category 1" knowledge, rather than on synthesis, analysis or evaluation.

Student movements of the 1960s indicated failure on the part of the educational enterprise to inculcate either the rudiments of reasoning or the ability to think as individuals. Individual independence was co-opted by mindless mass movements, wherein all the individuals began to look alike, sound alike, and act alike while espousing their individuality based on the rejection of the then current societal mores and values.

"Attentiveness" to science and technology

As science teachers, we have been trying to instill an appreciation of the enterprise of science into our students by the use of school alone. We have been trying to inculcate what John Miller has referred to as "attentiveness" to science and technology, but the dimensions of attentiveness exceed the boundaries of our classroom. The concept of attentiveness involves a disposition to be interested in science, to have enough knowledge to understand scientific issues, to read scientific articles, and to seek information through a process of acquisition from print, media and discussions, most of which are out-of-school activities. The wide variety of choices and the limited amount of time dictates that the average individual can be attentive to relatively few topics.

The way the evening newspaper is approached provides an index to attentiveness. A young child may search the paper for the comic page; a person looking for employment may immediately turn to the want ads, a sports fan to the sport page, but even the most avid sports fan is unlikely to read the entire sport section. He is looking for specific stories dealing with hockey or soccer or football and, among these, perhaps only stories dealing with the local team.

Except for very few renaissance individuals whose interests are exceptionally broad-ranging, most persons are attentive to a relatively small selection of topics. It is extremely difficult to assemble a group that can intelligently converse on politics, art, music, sports, literature and science. Try it sometime in any group with which you may be associated. See how wide-ranging meaningful discussion can become. Most social groups break up into special-interest areas, attracting people attentive to the issue under discussion. In the face of this acknowledged finiteness of attention in a universe of infinite complexity, what does research say about student attentiveness to science and technology? A brief summary on this point was published by Mary Budd Rowe in the December, 1980 issue of *The Science Teacher*. She showed that as high school students get a little older, their attentiveness increases but slightly. As fully 50% of the population is not college-bound, the data indicate that about 1% of graduates will be attentive to both science and technology, and less than 1% by far attentive to science only. After four years of college, 67% of this population is still attentive to neither science nor technology. 80% of those interested in science were also interested in technology, while only 67% of the technology-interested were also science-interested. The topics that seem to evoke the greatest interest were energy and biomedical issues, followed by ecology, space exploration, weapons research, and basic scientific research. This would seem to indicate that the utility of science is more appealing than science, and that science courses wherein information is displayed devoid of an application are less attractive than those courses that relate science to the society in which the student lives.

Another point emerging from the study by Mary Budd Rowe is that less than 25% of the supposed intelligensia is attentive to science issues. Lest we feel that while issue-oriented science is neglected, scientific knowledge is imparted, knowledge was measured by four, open-ended items involving the respondents defining molecule, organic chemical, *Amoeba* and DNA, four items to which any science student should have been exposed. With even very generous allowances made in considering what was a correct response, over 70% of the non-college bound and 40% of the college-bound could not identify any of these four. For those of us who take refuge in feeling that, while we do not synthesize and make societal applications, we at least communicate the details, these are depressing statistics indeed.

The study also showed a greater interest on the part of students in technology than in science, except for year fourteen. But again, the percentage was low and looking at the raw data is even more depressing. Respondents were asked to list all the *pro* and *con* arguments they had heard regarding construction of nuclear power plants, an item that would be apparently high in public awareness due to the controversies regarding such plants and the wide degree of publicity concerning them engendered by demonstrators and debate and reported in newspapers, television, and by other means. Unfortunately, about 30% of the college-bound and 60% of the non-college-bound were unable to list a single pro or con argument. When one considers the implications of these data when citizens are asked to vote on nuclear issues, one must tremble at the quality of decisions likely to be made.

As far as information acquisition is concerned, between 86% and 90% of the non-college-bound read no science magazine, and 72% to 80% of the college-bound did not. This certainly is an out-of-school activity that has obviously not been inculcated. A

science magazine, as defined, did not constitute esoteric publications. Those conducting the research would have been happy had the students looked at the *National Geographic, Popular Science, Popular Mechanics* or *Mechanics Illustrated.* Concentrating on something such as *The Scientific American* or *Science* would have undoubtedly produced more dismal data.

Science concepts in non-science disciplines

When we talk about the interactions of science, technology and society, either inside or out of school, we frequently, as scientists and science teachers, tend to don sack cloth and ashes and express our guilt by proclaiming *mea culpea.* However, it does behoove us to look at the other side of the coin. To what extent is science represented by the disciplines dealing with society in general? An article in the December, 1980 issue of the *BSCS Journal* by John Patrick gives us some data on this question. John Patrick studied how world history courses normally deal with science. The courses were evaluated on the basis of five commonly used school textbooks. The test was the number (percentage) of pages in each of these books that could be considered to deal with the impact of science in the period from 1500 to the present.

Considering the effect that the scientific revolution has had on every aspect of world history, it is difficult to comprehend the gross neglect it receives in these five popular world history books. In only one of the five did the influence of science upon society constitute as high as 7% of the content, and it descended to a percentage of less than 1. The question might well be asked of our brethren in the social sciences as to what they are doing about placing science in a societal context. It is difficult to imagine students becoming attentive to science when it seems to be neglected everywhere in the curriculum except in the biology course. Science confined to the science classroom cannot raise our scientific literacy in the time allocated, nor can it provide the societal implications of science without support that makes these implications more generally pervasive throughout our society. As Patrick notes in his article, social studies educators must accept a large share of the blame for deficiencies in teaching and learning about science and society.

The need to develop appropriate attitudes and values

The implication is that a linkage between school science, school social science and society in general would help alleviate this situation. One link between school and society is development of thinking that demonstrates a scientific attitude about the justification of beliefs, particularly if both science and social studies curricula support as a goal of education the development of persons sceptical yet receptive to new ideas, always willing to examine new departures in thought yet insisting that they be tested before they are accepted as valid. This is one way to help learners become competent decision-makers about science-related issues and public policies out of school. The development of decision-making skills is another link. Students in the sciences can be taught how to identify alternatives and connect them to consequences in order to formulate and use criteria that would distinguish the preferred from undesired outcomes. This demands the use of in-school knowledge and out-of-school resources. The skills of decision-making about public policy should be a central part of the education of citizens, but it cannot take place without involving the community in which such public policies are formulated.

The teaching of decision-making is a skill almost ignored in schools, yet it is not only a desideratum of education, it is a requirement of life outside school. We either make decisions on our own or we accept the decisions of those in whom we have confidence. Unless students develop their own internal frameworks or the access to authorities in which they can have confidence, they will accept secondary or tertiary data or, in some

cases, merely propaganda. In the political arena this is a particularly easily demonstrable sequence of events. Staunch party members who vote within a framework of party objectives vote for the party candidates without question.

This bell-shaped distribution of people suggests their toleration of differences in belief and their behavioural expectations. These are the kinds of students we receive in schools, and this mode of distribution becomes hardened with education and with the interplay of community forces. The group to your far left requires rigid rules and strict adherence to their rule sources. In school they are good memorizers and can parrot back information upon command. In the community they follow without deviation the dictates of a political party, a specific religion, a labour union, or a fraternal group. With their specific set of givens, they know the proper actions to take. These are the people who have clear-cut and definite opinions. They view the world and its problems as essentially simple. Things are true-or-false, black-or-white, on-or-off, right-or-wrong. For them, intermediate positions are either disturbing or do not exist. Shades of grey are not acknowledged. Sharp differences of opinion or interpretations at variance with their polar positions are ignored or contested. These persons normally are smug, self-satisfied individuals whose lives are guided by specifics and for whom the world will be a better place when all follow their precepts. Education, for these people has done little to open their eyes, but only to confirm their prejudices.

The largest group of individuals, fortunately, are those who operate within a certain framework of belief and behavioural expectation, although they do allow some flexibility. They are clear about the broad principles that provide a framework within which rules can be interpreted. Almost all human beings require some stability of cultural framework and the values in which they live their lives, and in most societies, the transmission of traditional beliefs and standards of behaviour or values has been one of the most important functions of education. School and out-of-school have become one when the school serves primarily as a conduit for community values and tradition. However, we are noticing a separation of what once was an homogenized pattern.

In the past, the responsibility for instruction in standards of behaviour and traditional beliefs has been left primarily to the church and to the family. Participation of schools in this instruction has usually reflected the values held by families and churches in the local community. However, since the values of the local as well as the larger society are breaking down, the schools must assume a greater role in helping youngsters establish values. Many students, particularly those in the 1960s and 1970s, were seeking new values. They went through a period of uncertainty, even in broad principles; they began to look for new sources of meaning and standards of behaviour because of the fact that they were living in times of drastic social change, where there was much unrest and insecurity. Value was attached to nonsense and importance attached to trivia. However, as usual with adolescent questioning of beliefs and behaviours, theirs became exaggerated in the search for something that could provide certainty in life, and then, from a beginning at the uncertainty region they moved toward the exact opposite end of the spectrum where rules, regulations and authority, perhaps those not shared by society as a whole, became an important anchor in their lives. Their search for new values led down most peculiar avenues, and many young people retreated into mysticism and cults that promised simple answers for complex problems.

The special problem of teaching values

The viewpoint is frequently expressed that values cannot or should not be taught in schools because values are essentially a private concern and should not be discussed or compared. Any attempt on the part of the teacher to influence or develop values can be considered indoctrination and thus is inconsistent with education in an open society.

The teaching of values should be the prerogative of other institutions, such as the family or the church, and values are not a part of the subject matter of the disciplines and, thus, are beyond the school's responsibility to teach. Thus, the out-of-school environment in these cases has assumed responsibility for certain areas which it no longer seems capable of reinforcing and turns again to the schools, seeking school support for out-of-school problems. The fact of the matter is that teachers, whether they wish to or not, must deal with value issues, and they do so every day. They constantly make value judgments in particular classroom situations with respect to school policies. Teachers need to be aware of the value issues that confront the schools and the larger society, and to have a well-developed concept of teaching in which they can deal with values and value issues.

The literature dealing with values can be grouped into three major categories. The first, recommendations of values – what should be, is the area that gives greatest concern. If the community is a monoculture and everyone agrees on what should be, this is not a problem. But for the most part, complex societies show no concensus of what should be. However, in courses in history and political science, sociology and science, and indeed almost every discipline, there are large bodies of descriptive analytical and explanatory studies of values of groups and individuals, and it is not beyond the ken of a skilled teacher to deal with what is and how it came to be.

It is the category of theoretical value systems which deals with what value issues are and the problem of value choice with which educators can probably deal most responsibly in terms of values clarification. But here one must be cognizant of walking a fine line between instruction and indoctrination, for it is indoctrination that must be avoided, while instruction is a requirement of education. Thus, both instruction and indoctrination may be based on evidence, but one emphasizes rationality as a process value, with the outcome value being autonomy, while the other emphasizes pre-determined beliefs and values. It is one thing to instruct on *how* beliefs arise; it is quite another to tell the students *what* is to be believed.

Science prides itself on inquiry into all the known evidence, but various groups attempt to persuade by detailed, selective evidence. What car is better than another? What painkiller is to be preferred for headaches? What clothes should you wear? and What breakfast cereal should you eat? Are all examples of persuasiveness which we normally associate with the advertising field, although there are many educational situations where teachers attempt indoctrination by selection of evidence rather than presentation of all the facts.

The ultimate outcome of instruction is encouragement of autonomy of belief, given acceptable evidence. The outcome of indoctrination is dissuasion from conflicting or contrary evidence or belief and an emphasis on conformity, as we noted earlier at the far left of the bell-shaped curve. It is unfortunate that when values are dealt with at all they tend to be in the form of indoctrination rather than in the form of instruction. As long as the indoctrination does not blatantly contravene the norms of the out-of-school environment, such indoctrination is tolerated.

When it is seen, however, as contravening societal norms, such as talking about population control in a strongly Catholic community, discussing pollution effects in an industrial area on which the local community depends for its livelihood, talking about human reproduction in a community whose mores dictate silence on the topic, explicating the germ theory of disease to a group whose preference is for witchcraft, or discussing evolution in a community to whose religious beliefs it is anathema, it produces negative community feeling, even though each position could be defended on the basis of a rational and open argument considering all the data.

ERIC

The need to understand science – the danger of false perceptions

If schools and their surrounding environment are to work together to enhance science education, we must first comprehend that, by and large, science itself is poorly understood. There are those, for example, who cannot distinguish between astrology and astronomy. After all, they both deal with celestial bodies and both names sound somewhat alike and, in the public mind, except for news of recent space probes, there may be more validity to astrology than astronomy, as practically every newspaper contains an astrology column daily but hardly any news that deals with astronomy.

We have done a poor job of delineating science as a process or a way of knowing. If you want a really discouraging experience, ask your students to define science, and do not accept cookbook definitions, such as "Science is a body of organized knowledge". Demand an answer that indicates a comprehension of the contributions and limitations of the processes of science. If your students are a typical cross-section, the answers will be uniformly disappointing. To many people, science is a miraculous event by itself, and they see nothing wrong with connecting it with miracles.

The knowledge explosion which has resulted in an excess of unsifted and unsynthesized data understandably confuses the lay public and, in many cases, scientists themselves. The amount of misinformation that exists in an unrectified state is unacceptably high. In matters of nutrition, for example, one needs only to examine the paperback books with which the public is besieged concerning diets, fad diets, dangerous diets, unproven diets, or diets that deal with everything but nutrition, so that we have one group swearing by the salutory effects of blackstrap molasses and yogurt while another is insisting that calories do not count. The field of nutrition is not so confused and confusing as public print would have it be, but as no one particularly explicates a balanced diet and caloric requirements, it is no small wonder that the public is pulled and hauled from one bit of faddism to another, with out-of-school propaganda contravening in-school instruction.

What I deprecate most is that very little effort is made to counteract this faddism by simply stating that most of it is unproven, non-scientific bunk. Desperate people, however, turn to desperate remedies. Those whose congenital plumpness has received no aid from organized nutrition seek it elsewhere, just as those whose cancers have been diagnosed as incurable seek out quack remedies such as laetrile. There is nothing to be lost but money and, eventually, one's life. The schizoid nature of our society where in the United States, on the one hand, the Surgeon General's office indicates that smoking is harmful to one's health while, on the other hand, the Department of Agriculture subsidizes the raising of tobacco, constitutes a conflict in values and a confusion in society. It is difficult for a teacher who smokes to exhort students not to. One has about the same degree of confidence in such injunctions as going to an overweight doctor who insists that one should reduce.

Confusion between science and pseudoscience

It is one thing when we have people representing science and technology arguing over scientific matters, but a lack of precision in our scientific resources has created a credibility gap between the science taught in schools and the out-of-school perceptions of science. The interest of the lay public has been aroused in new pseudoscientific, semi-spiritual theories that mix the supernatural with science. An article not so long ago in *Science* called these "intellectual poisons" and urged more schools and scientists to become concerned with debunking pseudoscience. Dr. Paul Saltman of the University of California at San Diego noted that this mythical-versus-scientific friction is felt by most people. He said, "I see today, as never before, an intense and polarizing struggle for man's mind between the forces of faith and mysticism and science and religion. Religion and science have legitimate points of contact in frontier fields, such as biomedical ethics

in the problem solving for human society when a rational, sensitive approach is used. But, the scientific community's response to mystical pseudoscience cannot help but be 'know-nothings should not inherit the earth'."

A perusal of books available to students in their out-of-school environment reveals concern with the occult, astrology, the Bermuda triangle, UFO's, faith-healing, and the secret life of plants, among others. Are these the kind of out-of-school resources to which we should refer our students, or are they antithetical to what we are trying to teach in class?

Part of our problem results from the very success of science. We now have so much scientific information that it is difficult, if not impossible, for scientists to keep up, let alone the average non-scientist. We have created an information crisis, whereby each of us feels incapable of understanding, digesting or utilizing the superabundance of existing information. Overwhelmed by the explosion of scientific knowledge, many of our collegiate-age students are turning to cults, such as "The Jesus Movement", which offer mysterious truths and simple, comprehensible formulae for living. As anyone in science knows, simplifying the complex leads to incomplete understandings and self-delusions. By eliminating critical checkpoints, we open the door for questionable truths and create a group of self-deluders who, in turn, delude others.

One book that was popular in the out-of-school environment reported plants responding in extraordinary ways to both humans and events, and this type of presentation apparently has broad appeal. People find it very easy to reject hard-nosed standards of scientific investigation and verification because most do not even understand the criteria of science and feel that any one set of experiments is as good as any other. Neither the background of the individuals who propound such fantasies, nor the methods they use, are subject to any critical scrutiny by the average person whose resources are all out-of-school and, unfortunately, in many cases, not even by the supposedly scientifically trained.

When the experiments described in this book are duplicated by others, they do not produce consistently repeatable results, but the advocates of this type of so-called "experimentation" say that the results depend on the experimenter's attitude. We are told that it is the spiritual development of the investigator that is indispensable and, thus, a sceptical research will not have plants or psychic subjects responding in the same fashion as can a sympathetic experimenter. In short, if you have already made up your mind what the results are to be, your experiments will, strangely enough, support that position. By eliminating the initial scepticism of the scientist and letting the data fall where they may, one of the essential criteria for any scientific resource is eliminated. Further, it is next to impossible to remove these attractive alternatives because the rebuttals are never as interesting or newsworthy as the initial sensational announcements, nor do they reach the same population, which is, of course, a major problem with trying to synchronize in-school and out-of-school activities. Further, scientists in general are reluctant to spend their time denying what they regard as nonsense. Nevertheless, the insidious increase of non-scientific material passed off as science resources in our communities has initiated the beginnings of change, and many responsible scientists are now finding it obligatory to respond to materials they would not dignify by acknowledging earlier.

Bioscience, in April of 1974, editorialized against the return of superstition and specifically cited the 1973 *Secret Life of Plants* by Tompkins and Bird. In the *Natural History* magazine, the distinguished plant physiologist Arthur W. Galston debunked the claims that plants respond to human emotions and prayers and pointed out that such publications as *The Secret Life of Plants* clutter the mind with mythology rather than science, and those who attempt to order their lives on the principles and generaliza-

tions there put forth would be led seriously astray. James Bonner, plant physiologist from the California Institute to Technology, found it necessary to remind people that plants have no nerves, no central nervous systems, no way of processing thoughts and emotions. He further commented that the desire to find positive results leads people to fool themselves and noted that the ability of the human mind to self-delude is infinite. However, even Bonner expressed the opinion that it was a waste of time to get into the debunking business.

Another case in point is *Worlds in Collision* by Immanuel Velikovsky, which has gone through more than seventy editions since first published in the 1950s and has a stout cadre of adherents. There is a quarterly magazine devoted entirely to Velikovsky's theories, and he received a standing ovation at a presentation made at the American Association for the Advancement of Science meeting in February of 1974 in San Francisco. Velikovsky, if you recall, postulated that the Earth had several near-misses with Venus and Mars over the last few thousand years, which caused cataclysmic events on Earth before Mars and Venus settled into their present orbits. Despite ancient records showing that planetary motions then were the same as now and sound astronomical evidence presented by such as Carl Sagan of Cornell, *Worlds in Collision* is taken seriously by many. Sagan, in commenting on Velikovsky, noted that where he showed real imagination he was found to be wrong. Where he was found to be right, he had already been preempted by other workers, who predicted the same things but for the right reasons.

The danger of pressure groups in society

Why all this concern about matters that we would normally dismiss? Philip H. Abelson has responded by noting that pseudoscience books seek to create the impression of scholarship and verity. He felt that schools need be especially concerned about the impact of these trends upon their students. He noted further that it was not pleasant to contemplate a situation in which our future leaders are being steeped in fantasy and are exposed to a put-down of science without effective response. His comforting thought was that, in meeting these challenges to rationality we should all remember that although humanity is eager to accept mysticism, it is also capable of yearning for truth, which can be provided if the teaching of science is so directed. To insure that our sources of scientific information are accurate, we must be conscious of living in an age of increasing and irresponsible attacks on intellectualism in general and science in particular. In no area of science have the current attacks been so concentrated as they have been in the field of biology. Perhaps this is due to the nature of the discipline, which deals with life and all matters pertaining to it and, thus, has a relevance to the daily lives of most citizens not appreciated as occurring in mathematics, chemistry or physics. No one, for example, seems to single out a particular number for his spleen, nor does the public get exorcised about atomic weights, co-efficients of friction, or parallelograms of forces. As a participant in a contentious discipline, I occasionally yearn for the sanctuary of mathematics, where anger exists only upon failure to obtain a proper number during gambling.

Pressure-group interference in biology classrooms come from those who feel population should not be controlled and resent discussions that indicate that the world's population may soon outstrip the world's resources, as well as from those who feel that sex is a vile and dirty subject and inveigh against sex education in the classroom. Those who feel that classroom use of animals is improper petition through the ranks of the antivivisectionists. Those who question the germ theory of disease want their children excused from classes where such is discussed. Diet and nutrition faddists protest the balanced diet, others speak against fluoridation and some do not wish to have the potential of genetic engineering discussed. There are those whose fundamentalist religious beliefs are offended by the inclusion of evolution, and so it goes. Biology teachers are

faced with these constant, out-of-school pressures to leave out or alter something currently extant in the curriculum or to include materials in accordance with the desires of special-interest groups not in harmony with the objective teaching of science.

Because of our inability to categorize the scientific resources in the world around us, we find the problem not one of simple individual indignation about some facet of biology or science, but rather the utilization of inadequate resources that manifests itself in interference from the community in the conduct of the classroom. The issue can be considered one of academic freedom. Who determines the parameters of a discipline? The teachers and the disciplinary specialists or legislative bodies and special-interest groups? The concept of academic freedom is invoked to allow the teaching of a discipline as dictated by research and development in the field, without fear of reprisals or having to conform to local pressure-group mores. It has been a mechanism to keep classrooms free from pressures. It is now being abridged by actions of easily influenced people in the community striving to implement what they believe their constituents desire and who have little understanding of the nature of science.

This problem has been of concern in the out-of-school environment. I never, for example, expected to find an article on this problem in *TV Guide*, but Edith Ephron, writing in the *TV Guide* for the week of January 10, 1976, headed her article "Biased Science Reporting Scares TV Viewers". She introduced the problem by noting that scientifically untrained reporters are scaring the population to death and concluded with this statement: ". . . the networks should stop this scandalous process of allowing the scientifically untrained to air ill-informed, unbalanced and terrifying opinion to a scientifically untrained public. At an absolute minimum, interviewing should be conducted by scientifically qualified people. No documentaries on medical controversies should ever be aired that do not include representatives of all the schools of thought involved, and no reporter who cannot write a decent essay acceptable to the National Science Foundation, on the principles of scientific epistomology and, on valid hypotheses within the full context of available knowledge, should be allowed near such an assignment. If he can't do that, he can no more assess competing scientific studies than a pig can fly, and he should be sent back to his usual beat, collecting hand-outs and scavenging for gossip and leaks about political personalities. That's all he's been trained for, and that he is good at doing."

There was a follow-up to this story in *TV Guide* for March 20-26, 1976, where Edith Ephron reported on the reactions to her original story. She noted the pros and cons in response to her original article were roughly equal, but she was able to categorize them to note that all the critics, save one biologist, were non-scientists. None showed the slightest understanding of the reasoning in the original article or showed any concern over journalistic suppression of serious scientific dissent. The supporters, on the other hand, not only understood the column, but appeared to be in a state of joyous shock over it. The scientifically sophisticated group of readers understood the theme, the reasoning, and the conclusions and did not distort the original position. The non-scientific group, however, revealed mass and uniform distortion of perception, were unable to grasp the benefit-risk concept, and did not constitute an authentic scientific position, but rather symbolized a political position. Ephron then concluded that the responses to the original article confirmed her charges, that television coverage is illiterate and biased, and to this she now added the charge that it was politically biased as well. Politics may make strange bedfellows, but it is not the stuff on which sound science can be based.

In-school activities should incorporate out-of-school activities

When the use and misuse of scientific information has become so gross as to be a topic

of an essay in *TV Guide* we had best look critically at the role of the school in scientific information presented out-of-school. Are we being suitably critical in school of data presented to students out-of-school? Wide, uncritical acceptance of printed, visual or verbal data is leading us all down a path of no return. It fuels the fires of anti-intellectualism and anti-scientism. It makes all of our tasks progressively more difficult and allows the operation of a kind of educational Gresham's Law, where misinformation drives our information.

In short, I am asking that we turn our thesis around. Instead of concerning ourselves primarily with out-of-school science activities that support in-school education, let us concern ourselves with in-school education that incorporates out-of-school activities and subjects them to a reasoned and critical analysis in order to make congruent the real world of the community and the perceived unreal world of the school. Our objective should be to make school and life synonymous, and we can do this, not simply by asking the community to reinforce the work of the school, but insuring that the school concerns itself with the movies, the television, the newspapers, the magazines, the books, and the other out-of-school resources with which our citizens will spend the majority of their lives. Our aim should be to reduce the uncritical acceptance of data and pseudo-data and to provide a framework in which a critical facility can operate. We should foster a spirit that approaches precipitous action with caution. We should inculcate a comprehension of science; we should foster cerebral rather than visceral response and provide an informed basis for values clarification and decision-making.

It is difficult to live in two worlds and until such time as we can make the school relevant to the out-of-school environment and the out-of-school environment comprehensible in terms of school, we will continue to have an artificial dichotomy of school versus out-of-school instead of what should be a communal and mutually reinforcing enterprise wherein school and community interact, and educated citizens can work toward the goal of a reasoned and principled society.

3. INFLUENCES OF OUT-OF-SCHOOL ACTIVITIES ON CONCEPT FORMATION IN SCIENCE

Gerhard Schaefer
Chairman
Faculty of Education
University of Hamburg
Von-Melle-Park 8
2000 Hamburg 13
Federal Republic of Germany

Previous investigations on scientific concepts in school prove that by means of associative bridges such concepts are linked in many ways to out-of-school everyday life (Eulefeld & Schaefer, 1978; Schaefer, 1979 a, b; 1980 a, b). This linkage seems to be a burden for a precise concept formation which is one of the main objectives of science teaching in school and university. The pedagogical task in future will be to integrate both "lives" – the out-of-school life which normally is "issue-centred", and the in-school life which normally is "knowledge-centred", (Kelly, 1980) – in one life of the student which he/she can feel as a unity. The author, in order to illustrate this task, presented a threefold "burr model" (1979a) to make teachers and researchers aware of the fact that a concept has to be treated as one unity including the *name* (designation), the normed scientific *meaning (logic core)*, and the personal *associative framework* of name and meaning. Only this complex of three constituents seems to be the natural structure in the mind of humans which is "living", that is growing, adapting, evaluating, and acting in human behaviour (Figure 1).

Instead of distinguishing a "logic core" from the "associative framework" we could also distinguish a "public meaning" from a "private meaning" (Sutton, 1980). The public meaning, in the case of scientific concepts, is generated and often strictly normed by a "scientific community", whereas in the other cases this meaning is growing in a more flexible and also unpredictable way, as a generalized structure of associations frequently made by some other group or society.

The two distinctions, logic core versus associative framework and public meaning versus private meaning, are not quite identical. The first one, as demonstrated by the choice of terms, puts more emphasis on the *logical* character of the public meaning (logical relationships between sets, subsets, intersection sets, etc. of things or attributes of things), whereas the second one points out the *public* nature of this part of a concept which makes it an instrument of communication between individuals.

The first distinction is, so to speak, pointing to the relations between *things*, the latter to the relations between *people*. Still both distinctions are based on the same assumption of an *associative nature* of concept formation and concept structure, and only the accent of consideration is different.

In the following it will be shown how out-of-school and in-school experiences enter into such a tripartite concept structure.

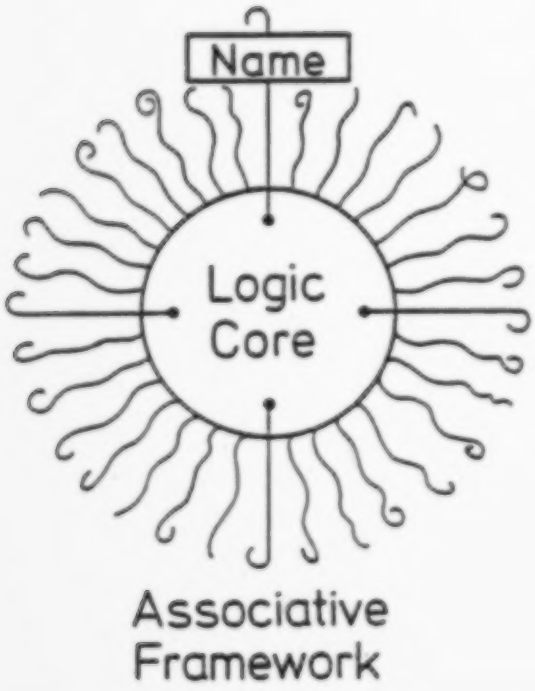

Fig. 1: "Burr model" of a concept showing the unity of name, meaning, and associative framework which seems to be the active component in everyday life (Schaefer, 1979a).

The concept of "equilibrium"

Equilibrium is one of the very early experiences children have with nature and with themselves. At the age of about one year the struggle with gravity begins, leading through different stages of locomotion (creeping, crawling, climbing) to the upright way of walking. At the same time, mainly between 1½ and 2 years, children begin to play with stones, bricks, lids and other pieces and to construct towers, houses and bridges. In this phase they learn, by primary experience with non-living things and with their own body, that equilibrium is something which has to do with *equality:* equality of forces, weights, distances, numbers "on both sides" of a central point. It is interesting to watch how quickly children grasp this law of equality with respect to their own body; here the "central point" is without question, i.e. in their own subject, and so the state of "equality on both sides" is found rather easily. This phase may be called "kinesthetic experience of equilibrium".

However, when constructing a house or a big tower which are outside their own body, children normally have more difficulties. There is no given "central point", and so it is hard for them to judge how many pieces or parts of pieces have to be put on one side and how many on the other. This kind of experience is more a type of "optical experi-

ence of equilibrium". It has to do with the development of a first visual imagination of symmetry based on some germinating idea of a symmetry axis or symmetry point.

In later years, from two years on, the experience of a see-saw is added to the concept of equilibrium, and the children will refine and confirm their concept by actually seeing a central point of symmetry with their own eyes, and by differentiating "distance" from "weight". This experience is picked up again in later years of school teaching when in physics the laws of a lever are treated.

All hitherto mentioned experiences contribute to a concept of equilibrium which is exclusively *static* which means that it is an equilibrium of forces resp. momentums. So the term "equi-librium" (= equal weights) is fairly justified for this phenomenon.

On the other hand, in later years, from the age of about three on, children frequently witness natural phenomena of stability, of "equilibrium" which are *not* produced by force or momentum but by *flows* of something (matter, energy, electrical charge, information). The most frequent examples of this kind are certainly flowing water in a brook or a pond keeping the water level constant, or a water jet with constant form. In those phenomena the "flowing something" is transported through the system in such a way that the efflux is equal to influx. Again there is "equality on both sides", however this time not equality of forces or momentums, but equality of flows. Although not being the type of "equi-librium" in the original static sense, these phenomena later on in school education are still called "equilibrium", synonymous to "steady state" (Bertalanffy, 1953). So the physiological phenomena of constant concentrations of glucose, water, carbon dioxide, and other chemicals in the human blood are called "physiological equilibrium", and the ecological phenomena of constant averages of predator/prey populations in an ecosystem over a longer period are called "ecological equilibrium", or simply "biological equilibrium".

But – do students realize the fundamental differences between the two kinds of stability phenomena, once these are identified by the same name? Investigations on the concept of equilibrium in the age of eleven to thirteen years show that there is a strong pre-determination of the concept from the pre-school experiences with the static phenomena, and that almost no elements of a steady state thinking are present in connection with the *word* equilibrium (Figure 2; see Eulefeld and Schaefer, 1974, English translation 1978, p. 51). Only after the students have been specially trained in ecological and cybernetic thinking over 12 lessons (ecological training alone is apparently not so efficient!), they associated remarkably often ecological words with the key-word "equilibrium" (Figure 2) including those showing a deeper understanding of the mechanism of ecological equilibrium (predator/prey relationship, regulation cycle, escalation cycle, competition system, oscillation, and others).

It can be concluded from the hitherto available data that it is possible, at least to some extent, to compensate associative loads of concepts which originate from out-of-school experience by a particular in-school training. Cybernetic terminology and thinking seems to have the power of overcoming one-sided early pre-school experience by abstraction from its sensory attributes and thus elevating thinking to a more general, more inclusive level. From this upper level of abstraction "down" again to new fields of concrete application (ecology, physiology, psychology, economics) seems to be easier than going the transverse way of "transfer" from one concrete field to another. Concepts from systems theory, cybernetics, mathematics (i.e. from formal sciences) apparently have a catalytic function in bridging the logic core of a concept, as it is taught systematically at school, with the associative framework which seems more the product of out-of-school experiences with nature.

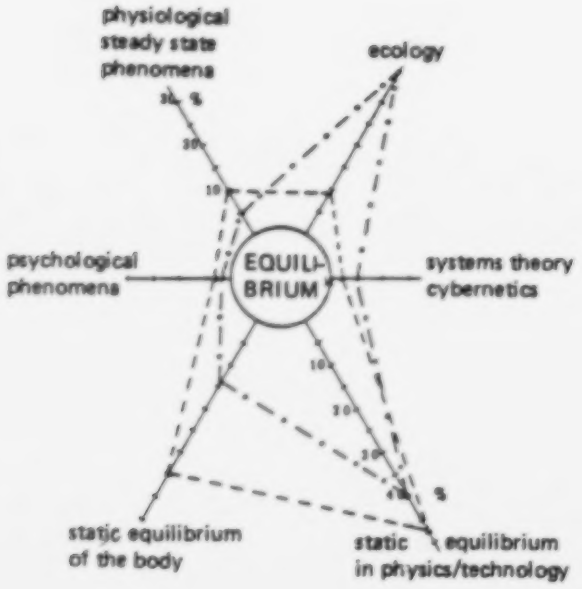

Fig. 2: Associative framework of the concept Equilibrium, as given spontaneously by 11 to 13 year old West-German secondary school students. n = 407. The associations have been categorized to 6 groups. Note the high load with associations of the "static" kind (physics/technology, balance of our body).

-------- Results of the pre-test.

— · — · — Results of the post-test, after 12 lessons training in biocybernetic thinking.

This bridging can be systematically planned and performed in school by using conceptual hierarchies beginning with some concrete and possibly one-sided experience, going upwards to the abstract, formal level of systems concepts, and then going down again to all possible fields of concretization of such concepts (see the corresponding role of "advance organizers", Ausubel, 1968). Such a hierarchy, applied to the concept of equilibrium, is shown in Figure 3.

If the students once have conceived this hierarchy and really understood the different cases of stability they will be able to organize their rich and sometimes chaotic out-of-school experience under one superordinate term which now may be called "equilibrium" in a broader sense than before.

Our investigations with eleven to thirteen year olds (Eulefeld and Schaefer, 1974; 1978) and sixteen to eighteen year olds (Bayrhuber and Schaefer, 1978) have demonstrated that this hypothesis is well supported.

The concept of energy

Whereas equilibrium is a phenomenon which a child will envisage very early in its life with its own body and with simple things in its environment, i.e. by *primary* experience,

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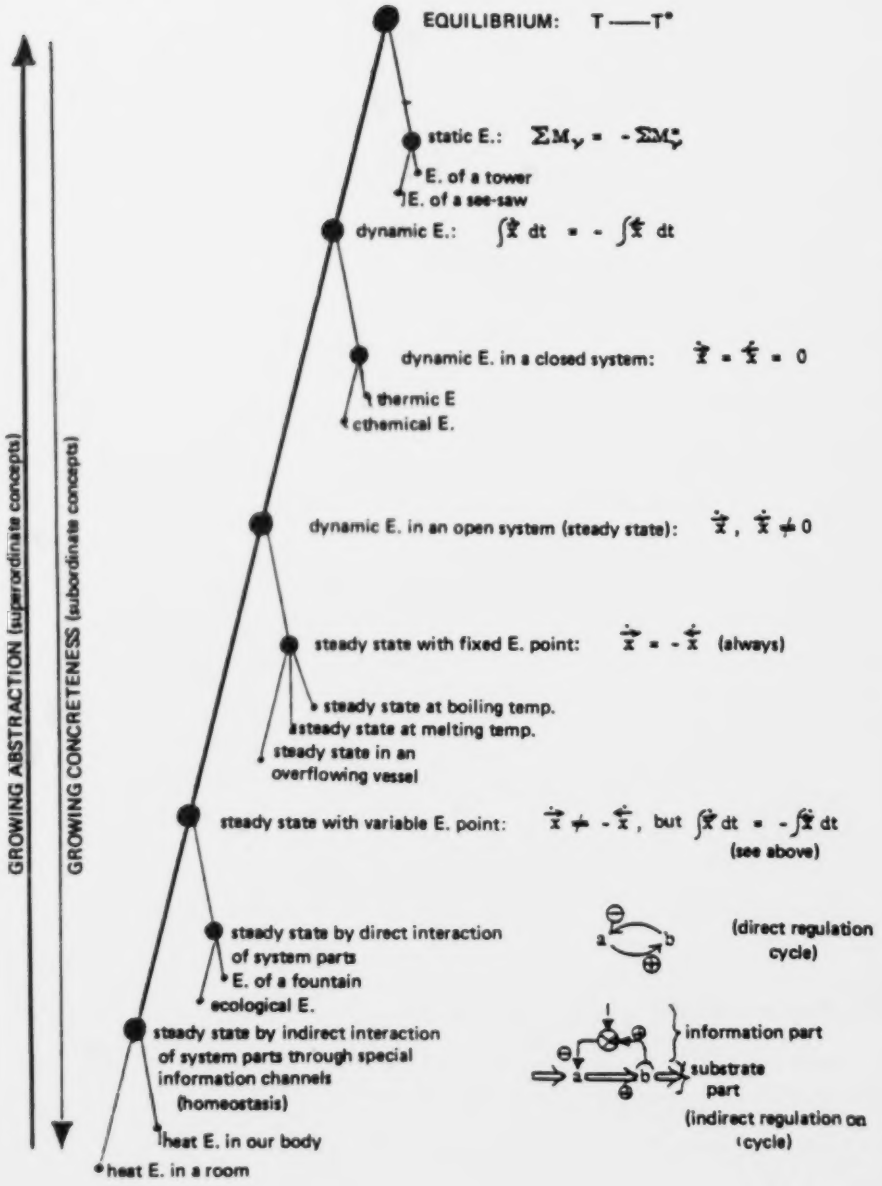
EQUILIBRIUM: T ——T°
static E.: ΣM_y = - ΣM_y
E. of a tower
E. of a see-saw
dynamic E.: ∫ẋ dt = - ∫ẋ dt
dynamic E. in a closed system: ẋ = ẋ = 0
thermic E
chemical E.
dynamic E. in an open system (steady state): ẋ, ẋ ≠ 0
steady state with fixed E. point: ẋ = - ẋ (always)
steady state at boiling temp.
steady state at melting temp.
steady state in an overflowing vessel
steady state with variable E. point: ẋ ≠ - ẋ, but ∫ẋ dt = - ∫ẋ dt (see above)
steady state by direct interaction of system parts
E. of a fountain
ecological E.
steady state by indirect interaction of system parts through special information channels (homeostasis)
heat E. in our body
heat E. in a room
(direct regulation cycle)
information part
substrate part
(indirect regulation on cycle)
GROWING ABSTRACTION (superordinate concepts)
GROWING CONCRETENESS (subordinate concepts)

Fig. 3: Hierarchy of the concept of equilibrium. Instrument for in-school education which is able to produce a logic core of the concept adaptable to all kinds of pre-school and out-of-school experience.

energy is more a phenomenon of secondary experience to be found in mass-media, public discussions, and in physics textbooks. Although many students think (and are told in physics!) that energy is a basic concept of science playing a role as a variable of conservation in all natural processes, still we should keep in mind that this physical variable is highly abstract and cannot be expected to be a phenomenon of early and primary experience out of school.

An investigation of 113 students aged seventeen to eighteen (advanced biology courses in the upper secondary level), by means of free-association and free-definition tests showed a ranking of free associations as demonstrated in Figures 4 and 5.

Although after four to five years physics teaching in school, there should be enough secondary experience about the equivalence of energy and work (energy as "stored work" or the "ability to work"), and also some primary experience gained by experimenting in school, the first four ranks are occupied with association other than work (Figure 4). It is interesting to see that still "force" is the most frequent association, although for about 100 years physicists have distinguished strictly between force and energy and are teaching this distinction thoroughly in schools and universities. Interviews with some of the students throw some light upon the possible reasons. The question whether they have ever experienced *energy* in their own life, e.g. in their own body, was answered negatively. The students, after some time of deliberation, said they would not feel "energy" in their body but, frankly spoken, *force*, or tension, vigour or irritation. Asked for energy experience with phenomena outside their body they admitted that in all physical, chemical or biological experiments in school they only experienced force, distance, heat, pressure, light, water and so on, but *not* energy. Energy was the *word* the teacher used, and not what they really perceived with their senses. They remembered definitions about work, e.g. "work is the product of force and distance", but they confessed that they never were able to develop a direct feeling for such a product (especially as it is a *scalar* product of two *vectors* of a completely different nature, and not just the arithmetic product of two figures).

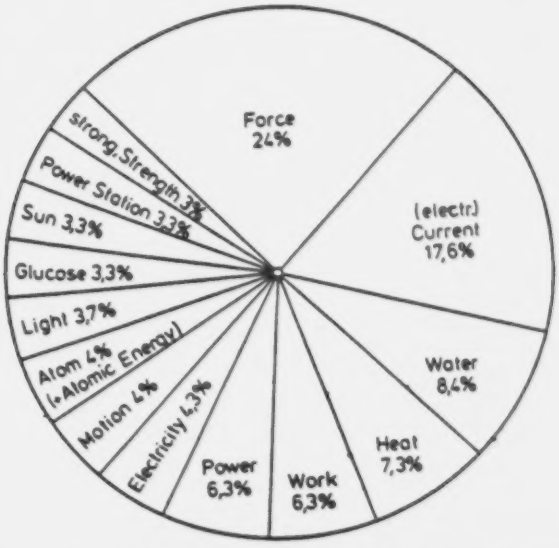

Fig. 4: The 14 most frequent free associations to the key-word "Energy". 113 biology students of the upper secondary level (age 17/18).

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So Figure 4 again demonstrates the strong influence out-of-school experience has on the development of scientific concepts, at least on their associative framework.

In Figure 5 the reader may recognize the considerable amount of associations coming from the areas of "household" (about 25%) and economics/energy policy (also 25%). The maximum is found in the category "physics, technology" (70%) where most students think the concept energy is "at home". No wonder, because in this area, by means of primary *and* secondary experience, they are gathering most of their knowledge and their associations around energy. The relatively small percentage in the categories "biology" and "chemistry" again shows that in-school education is rather inefficient with respect to the *associative* level of concepts, as the tested students were attending biology courses and so should have "experienced energy" in the biological context quite a lot.

This observation is supporting the previous statement that "energy" is a highly abstract and difficult concept. The first concrete experiences with "energy" in the first years of life are made in the biological sphere in the form of food ("fuel"), muscular work and exhaustion, and heat and cold in the body. These early pre-school experiences, however, are obviously not subsumed under the general concept of "energy", neither in the time before school nor later on in school. They remain separate associative knowledge in the range of "biology", and are not attached to the "physical" phenomenon of Energy, in spite of many years in-school training. This phenomenon is called "range-specific thinking" (Seiler, 1973), which, in fact, is nothing but a *range-specific associating*.

Most remarkable is the fact that even in the spectrum of free *definitions* which are the result of deliberate thinking, there is no increase of elements in the categories "biology" and "chemistry", but on the contrary a further decrease (Figure 5). If there is little linkage of energy to biological and chemical elements on the associative level, it could at least be expected to occur on the level of logical reasoning by means of subsumption mechanisms in the students' brains. In the interviews students answered that when thinking about a definition of energy, they were thinking in the *physical* category alone because they expected energy to be basically a physical phenomenon. It has to be repeated that this way of thinking occurred in students attending *biology* courses! The explanation can only be: definitions are always made with certain criteria of selection and valuation relevant to the concept under consideration, and these criteria are not always objects of the same conscious consideration but often remain at the subliminal, associative level. The high dominance of physical/technological elements in the associative framework of energy (Figure 5) and the high ranking of individual associations from this field (Figure 4) demonstrate already the actual existence of such subliminal criteria, and they were confirmed by the students in the interviews. As the concept of energy is the product of "exclusive thinking" which is typical for normal physics teaching, all associations around energy going beyond the purely physical skeleton are excluded by the students in the definition according to their subliminal physical and normal expectations.

Another interesting observation in the associative framework of our students is the positive emotional charge of the concept of energy which, according to the interviews, is due to connected positive imaginations like power, progress, success, standard of living and so on. It has to be mentioned, however, that recent data taken from university students show an opposite effect: energy here was more associated with negative emotional aspects like destruction, oil crisis, war, dependance and pollution. Most of the individual associations given by the students (more than 90%) demonstrated quite clearly that they are originating from out-of-school and not from in-school experience. This again proves the great importance of out-of-school influences for concept formation in school.

Also the general category "psychological aspects", as the individual data show, can

be traced back to out-of-school life. Most of the associations are derived from personal experiences with "vigour", "drives", "strong will", and related variables. An unsolved problem is the minimal percentage of associations coming from the area of traffic. This is particularly striking as most of the students are driving their own car or a motor bike and so are confronted with the energy problem every day.

The interviews did not bring the solution, as the students could not explain themselves why they did not think spontaneously of traffic matters in connection with energy. If we compare the result of the association tests with that of the definition tests (Figure 5), we find a marked decrease of percentages in the "out-of-school categories" (even in biology and chemistry, which are "out-of-physics"!), but an increase in the formal category. This shift is a clear effect of in-school training, as is demonstrated by the individual formulations.

This effect could also be observed in previous investigations on other concepts. It shows that free associations are a of "raw material" for thinking which is being selected and refined in the process of reflection. The whole spectrum of associations which is demonstrably active in everyday decisions is narrowed down to very few categories by scientific thinking. So Figure 5 shows the importance of including the associative framework in the total structure of a concept, as is done in the burr model (Figure 1), because only then will we be able to judge the impact a concept like energy has on our life.

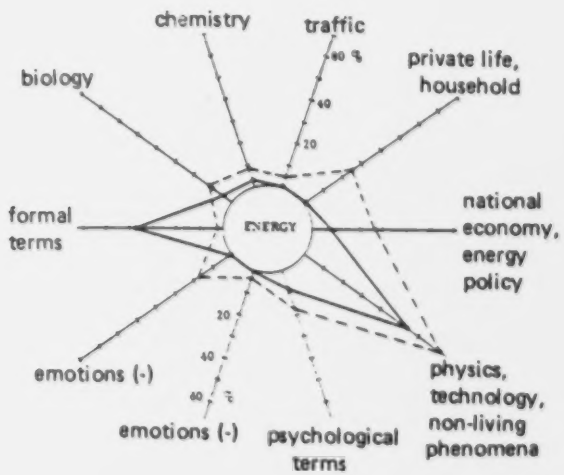

Fig. 5: Distribution of free associations and elements of free definitions over 10 different categories. Same population as in Fig. 4.
------ *Free associations.*
——— *Free definitions.*

Exclusive and inclusive thinking

Concepts, as shown in the foregoing with the examples "equilibrium" and "energy", always consist of a more or less rigid central part: the logic core, and a highly flexible, open "husk", the associative framework. Strictly taken, the "name" (designation) of a concept also belongs to the framework, as normally it is attached by means of association

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rather than by logical reasoning. If we want especially to point out the importance of the naming (as a linguistic concern to distinguish between designation and designated, between "sign" and "meaning"), we should demarcate the name from the rest of the associative framework thus producing a *threefold* concept structure, as it was illustrated in Figure 1 as the "burr model".

Whereas the logic core consists of a rather *limited* number of well-defined auxiliary concepts (superordinate and subordinate, system parts, comprehensive system) and their relations, the associative framework is principally open, i.e. *infinite* in number of elements and their interconnections. As, on the other hand, the human brain in each moment is able only to operate consciously with a limited number of contents, it tends to operate with "closed figures", "super-signs", and thus with the logic core of concepts instead of the vast network of concrete associations.

This leads to a tendency to exclude information which seems "irrelevant" to the object of thinking, what in truth means: irrelevant to the present *value* system of the person. As Berlyne (1960) points out this value system may change during the process of problem-solving and may terminate a cognitive conflict just by affective re-valuation.

Human beings always try to simplify by exclusion. They prefer "exclusive thinking" (Schaefer, 1980a) which is the *thinking in closed systems.* However, as natural objects very seldom, and biological objects never, are "closed" to their environment, this kind of thinking ever again leads to misinterpretations of the world around us and also to serious mistakes. So it is a primary task of education to counteract this general human tendency by training "inclusive thinking". Inclusive thinking means the inclusion of the outside into the inside of a system, what is identical with the opening up of system borders again and again, once they have been established and fulfilled their (always transitional) function. In Figure 6 this is illustrated in a diagrammatic form.

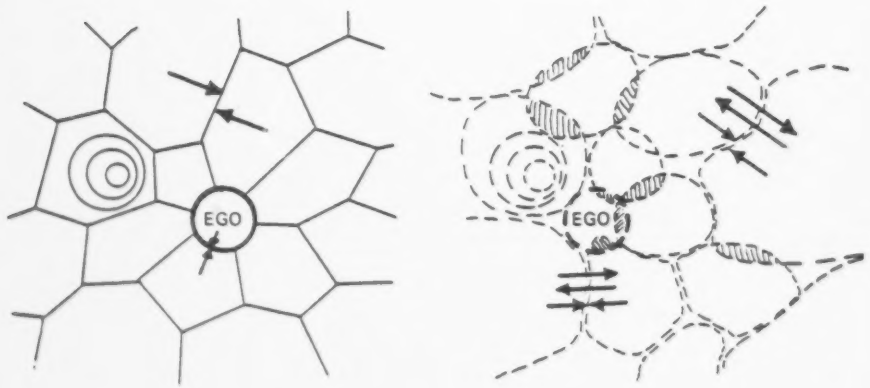

Fig. 6: Illustration of exclusive (left) and inclusive thinking (right) as a thinking in closed and open systems. As the circle in the centre shows, the structure of Ego is considered to be strongly involved in and responsible for the way of thinking.

The figure demonstrates that inclusive thinking is not a thinking without any demarcation of areas (that would not be "thinking" any more), but a ***thinking in compartments***, in open systems. This way to thinking is the only variant appropriate to the living world, because it is homomorphous to the structure of biosystems which are equally characterized by fluent transitions, open borders, high variabilities, and the phenomenon of evolution, i.e. the change of structure in spite of its principal stability.

A similar polar distinction was made by Guilford (1967) who separated *convergent* from *divergent* thinking, and by Dorner (1979) who, like many ecologists and psychologists today, differentiates between *linear* thinking and *network* thinking. However, underlying these two classifications of thinking there are the fundamental processes of exclusion and inclusion, in the first case with respect to the method of approaching a goal, in the second case with respect to the way of treating a causal network. So exclusive/inclusive thinking seems to be the primary distinction, and the two mentioned forms are special cases.

If we look back into the time of pre-school experience and also watch the out-of-school life around us, we may realize that our adult world is full of exclusive reactions, full of the "either-or", and that there is a great reluctance of people to open up or change borders. We are happy, if we have structured the world in a pattern of exclusive nations, regions, generations, sexes, working classes, professions, disciplines, technologies all of which give us security for the moment. But – don't we take this pattern too seriously, and use it too rigidly? If we want to survive in the long run, we have to adapt to *life*, and this means we have to develop an elastic, overlapping, here and there changing pattern of the world.

Let us imagine, for a moment, that children would not be the learners, but our *teachers*. What can we learn from them? One day living together with a child at the age of two to three years, and watching it with full attention, will show us: the child constructs order, and disorder again; it builds up a fence separating toy animals from others, and destroys the fence again: it arranges toy cars in a clearly structured line, and suddenly kicks them away again. The child acts exclusively, and again and again overcomes the achieved exclusive structure by its inclusive way of thinking, feeling, and acting. It needs order, and it produces order. But it always again dissolves order on behalf of a higher, more complex, more durable order of "life". If inclusive thinking would be contrasted with exclusive thinking as a strict alternative, it would become "exclusive" itself. "Inclusive" however, if correctly understood can only mean the embedding of also the exclusive variant in the total way of thinking, i.e. the integration of exclusive *phases* into the whole. Small children, as it seems to the author, are real masters in this! If their mentality which is still so close to the origin and so far from adulthood, could be carried on and preserved, energy would no longer be interpreted as "physical", and life would no longer be reduced to the molecular level. The logic core of scientific concepts which we are so proud of in-school teaching because of its "preciseness" would no longer make us sick in our mind, as it would not be regarded as purpose in itself, but a necessary tool of education. For what reason did the triennial conference of IPA (International Playground Association) in 1981 at Rotterdam choose the theme "Growing up in an Adult-World – Beyond Play and Recreation"? What is wrong with this "Adult-World" in which children do not fit in?

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4. BIOLOGY OF LEISURE

A.N. Rao
Department of Botany
National University of Singapore
Lower Kent Ridge Road
Singapore 0511
Republic of Singapore

One aspect of out-of-school activity that has so far received little attention by the school science teacher is the preparation of pupils for the effecitve use of leisure time. This article examines some of the scientific principles involved and in particular, presents an approach to the biology of leisure.

In quantitative terms leisure is the time left over after completing work necessary for maintaining life. Leisure hours may be spent in relaxation, sports or in creative activities such as art, politics or religion. Excessive leisure is always associated with elitism, since people who can afford lots of leisure need not spend a great deal of time earning their living. It is therefore said by traditional lore that a life of leisure is beautiful and a sign of nobility and that it indicates the comfortable position of an individual in regard to income. So much for traditional lore. The reality is that leisure should not amount to non-productive consumption of time and a life of idleness at the expense of others. A functional society cannot afford to support full-time leisure for all.

Leisure usually indicates only the free time available, whereas relaxation includes physical inactivity as well as a mind free from worries and anxieties. So both body and mind are involved in utilising leisure and enjoying relaxation. Leisure activity therefore is the sum of free time and relaxation. The subject Leisure has been very well discussed by economists, sociologists, psychologists, medical doctors, theologists and philosophers. Scientists in general and biologists in particular, however, hardly have discussed the subject, since leisure involves inactivity except for non voluntary functions in the human body.

Sociological versus scientific views of leisure

Sociologists have attempted to classify the activities of life into certain categories (Kaplan, 1975). While most categories reflect conceptual or functioning aspects, the physical body and functioning of the mind play a vital role in most. The following classification is by M. Kaplan (1975). *Leisure – Theory and Policy* – John Wiley, N.Y.

Religious:	Deities, ethics, hierarchies, symbolisms
Marital:	Sex regulations, legal relationships, roles, life-styles
Educational:	Teaching, research, service, counselling
Political:	Legislation, administration, enforcement, symbol
Economic:	Production, distribution, consumption, ideology
Leisure:	Condition, selection, function, meaning

Sociologists analyze proportional times spent on these types of activities by various categories of people.

Life of people in urban areas, for example, is regulated by fixed or definite working hours, demands on work and datelines to be met, transportation facilities and frequencies, regularity of attendance, leave situations and so on. In rural areas the nature of occupations are such that the utilisation of time is more flexible and one can more easily make necessary adjustments. Workload could be heavy or light depending on season, climatic conditions, and other factors. Leisure activities must "fit".

The scientific approach treats leisure phenomenon as rigidly as it analyses types of human behaviour. The approach includes:

(a) collection and analysis of data;
(b) establishing generalisation, principles or laws;
(c) a study of advantages and disadvantages of leisure.

Most outdoor leisure activities require suitable environmental conditions, either natural or man made. Biological aspects include the need for pollution free atmosphere and the availability of suitable sites and areas. In urban situations the provision of many of these conveniences involves considerable planning, finances and maintenance of suitable environments – for example, places free of pathogens, bacteria, viruses and other causal agents. Data is needed on all those aspects.

Biological implications of leisure are hardly studied at all. Animal physiologists have, of course, worked out the principle and factors involved in the straighforward contraction and relaxation of muscles. Relaxation of muscles takes place when the endoplasmic reticulum rebinds the calcium ions. Following this ATP is restored and actin is dissociated from myosin. Based on experimental data, the latent period, contraction period and relaxation period for the muscles have also been worked out. The period for any change varies depending on the size and position of the muscles. Psychologists also study aspects of leisure. They usually concentrate on stress and strain phenomena with reference to the mental health of the people. How can we make use of their studies in the optimal development of leisure activities? How can this type of knowledge be utilized in planning leisure activities? These questions to the physiologist and the psychologist remain largely unanswered and this poses a special challenge for the schools.

Advantages of leisure activity could include the relaxation of mind and body. The type of leisure that any one person would enjoy, however, would depend on personal preferences, time available and the cost involved. Disadvantages or harmful aspects could include excessive self indulgence such as smoking, drinking, over-eating, drug habits, physical fatigue and other aspects. All these involve many biological factors. These need to be investigated if a proper balance sheet is to be developed for any individual.

Land use for leisure activity

The assignment and use of land for recreational purposes in towns and cities is a well established practice both in developed and developing countries. The location and area of such places depend upon the population density, availability of the land and the needs of the people. They could be parks, pleasure gardens, seaside areas and others. Most are organised places with planted areas and man-made landscapes. Nature Reserve and National parks also provide excellent recreational areas. The original vegetation may be left undisturbed using as little area as possible for paths, benches and other "improvement" – so that visitors can relax amidst the natural vegetation and scenery.

A study to evaluate the balanced biological merits of the following areas should be undertaken:

1) High density recreation areas
2) Picnic grounds
3) Seaside areas and facilities

4) Historic areas – temples, churches, castles, palaces, forts
5) Natural environments – nature reserves, forest margin areas, reservoir areas, beaches
6) Unique places like waterfall areas, lakes and others
7) Natural wilderness, deep forest and so on.

Outdoor recreational activities helpful in spending leisure time out-of-school include a variety of sports, hobbies, nature study and may include 'borderline' academic educational activities. Almost all require suitable environmental facilities involving proper biological control and management.

These activities include the following: picnicking, driving for pleasure, sightseeing, swimming, walking for pleasure, playing outdoor games and sports, fishing, attending outdoor sports events, boating, bicycling, nature walks, sledding, hunting, attending outdoor concerts and plays, camping, ice skating, horseback riding, hiking, water skiing, bird watching, snow skiing, canoeing, sailing, wildlife and bird photography, mountain climbing and many others.

The gadgetry required, its uses, and the related activities may upset or damage the environment and its components. Necessary safeguards have to be built in. The supervision and maintenance of parks, forest reserves and other types of areas are closely connected in the orderly management of natural or man made environments. Biological principles involved have to be rigidly followed if the environment is not to be despoiled by leisure activity.

Shorter work periods perhaps involving longer weekends (say of three days) would increase leisure hours. How to use the extra time becomes a central problem. A related issue is the cost of leisure.

Certain leisure activities are almost free of cost to everyone in a community; for example, walking or mountain climbing in nearby places. People of different status and earning power watch the same T.V. programmes. The influences of the programmes may influence the biology of behaviour among different people belonging to a particular society.

Studies of watching television as a leisure activity

In advanced western countries television has become an indispensable medium, helpful in utilizing leisure hours. In the United States, according to a survey report, adults on an average per week spend 6 hours and 10 minutes and the children spend 30 hours a week watching television. The ratio is almost 1:5. The average viewer would witness about 19,000 acts of violence each year. Professors of child development have concluded that intense T.V. watching and anti-social behaviour of children may be closely interrelated. Television watching, however, certainly cuts down conversation, reading habits, games, and outdoor excursions. The frustrating hours and varying moods of individuals can be "worked out" silently in front of a television.

Another effect that the T.V. habit has left on children is reduction in concentration. Concentration in the classroom lasts for shorter periods with many breaks in between, similar to watching T.V. programmes with intermediate commercials.

Studies of urban and rural patterns

Relaxation in the densely populated urban areas has its own pattern. People who live in high rise flats have to depend on man made environments; whether they be playgrounds (outdoor or indoor), swimming pools, community halls and so on. Because of lack of facilities they may be kept away from certain types of leisure activities. Their counter-

parts who live in suburbs or in the country can use their weekend leisure in other ways such as gardening, farming and related activities. These differences have rarely been explored in school programmes.

International differences

Leisure patterns are well set in western or developed countries whereas in the developing countries the patterns are widely variable. Rich people in developing countries usually follow the patterns of their counterparts in the western countries. Whereas the middle or the poorer class people usually spend "leisure" hours either attending to domestic chores or home improvements or they may even work for extra time to earn more money. Having two jobs and extending working hours in a day is very common in many developing countries. The only exception to this general trend perhaps is the occasion for festivities, when everyone observes certain common practices like going to the temple or church, enjoying a feast and so on.

Adult education and extramural studies take away the leisure time for certain classes of people who may wish to improve their academic knowledge or standards. Continued long working hours are common among these people and this trend is more significant in developing countries.

Biological museums, science centres, bird parks, zoos, and so on provide suitable opportunities for people to spend leisure time. They have distinct beneficial advantages. The number of such institutions is, however, relatively less in under-developed countries, and their quality is also very variable.

In temperate countries certain types of leisure activities are dependent on weather and seasonal conditions, whereas in tropical or sub-tropical conditions the weather is generally suitable for people to enjoy leisure throughout the year except in monsoon or rainy periods.

In the more developed countries, with increased technological development, computerisation and other trends, the free time available for leisure is increasing, and the hours of work per week is decreasing (Figure 1). The data presented show the general working pattern of the industrial workers in the developed countries of the world. This pattern is absent in under-developed countries.

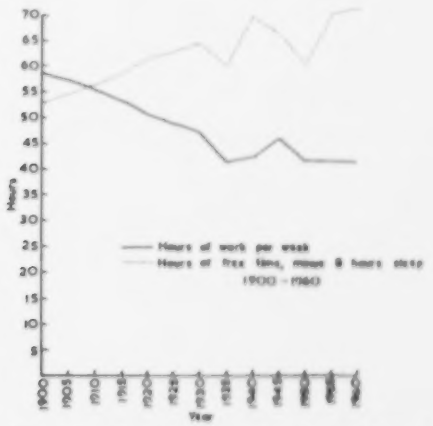

Fig. 1. Hours of work and free hours per week, minus 8 hours of free time, 1900-1960 in developed countries of the world (from Kaplan, 1975).

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The special problem of tourism

Increased GNP, productivity, affluence of certain countries and global transportation facilities have increased tourism in different parts of the world. Certain countries keep their doors wide open to attract tourists, even going overboard in allowing drug use, promiscuity, excessive gambling and other somewhat anti-social behaviour. There are obvious social changes, therefore, in an open policy towards tourism.

The biology of tourism is very interesting since it may involve tourists visiting natural habitats and the popularisation of various places in certain countries, including wild life sanctuaries, mountain peaks, and natural areas of animal and plant life. D. McCannell in his book *The Tourist* (McMillan, 1976) writes as follows:

"Add to the animal life, wide, sunlit plains, deep tropical forests. towering mountains, and the very source of the mighty river Nile, and then for good measure add the vast roads in East Africa. . ."

"Dagestan, a land of wild mountain beauty and exotic confusion of 32 languages and dialects, is stirring after long isolation and is moving to attract foreign tourists to diversify and stimulate its largely sheep and vineyard economy . . . Travellers can drive for dozens of miles through the grassy plateaus and along mountain roads without seeing a single house or other sign of habitation . . . An old shepherd, clad in flowing cape and a tall lambskin hat, turned slowly from his grazing flock as a bus stopped suddenly on a narrow, twisting dirt road . . ."

The flora and fauna of several interesting areas are frequently described in popular terms for the benefit of tourists. The habits and life histories of wild animals are closely studied and reported so as to make clear to tourists their drinking, grazing, feeding and breeding habits. Even the timings of these behaviours are frequently well recorded and publicised. There are obvious dangers in making this type of information generally available to uncritical readers and users.

Aborigines camps in certain countries are frequently popular tourist attractions and anthropological details are often explained in simple tourist programmes and outlines. Biological knowledge is presented in a popular form and used for commercial benefit, not always accurately and not always to the benefit of science.

Lack of scientific aspects in planning for leisure

At present, planning for the future of leisure mostly involves social, economic and philosophical aspects. The scientific aspects involved are only of very minor nature.

The biological science of leisure or biological implication of leisure have yet to be properly identified and the suitable value systems have to be defined. Various biological aspects like conservation, preservation, multiple use of land or water areas, ecology and quality of environment have to be further examined to evaluate their significances to improve the kind and quality of leisure.

Modern society is increasingly dependent on computerisation and automation devices. Business organisations, factories, offices, laboratories, medical establishments, supermarkets and households use various gadgets to save time and labour. In the course of time even food may be processed, cooked and served by automatic machines. The time saved by all these operations could be considerable and very soon there may be abundant leisure available. How to use this extra time and leisure is the important question that we will be asking in the future. The biological implications could be considerable.

Advances in medical research are bringing many vast improvements in controlling various diseases. Transplantation surgery, antibiotics and other techniques help to extend

the human life span. The extended life involves more leisure time, which has to be spent in a worthy manner.

Improvement in technology no doubt do help to foster physical and material development. Greater efforts are necessary, however, to improve the *quality* of life including spiritual, cultural and emotional aspects. Using leisure more effectively should be directed to any one or all of these aspects. The biological implications involved in all these matters should be properly evaluated.

Implications for out-of-school activities

We tend to take leisure for granted. This article has attempted to show, however, that there are scientific issues involved in the optimal utilization of leisure time. School science could help pupils prepare for the wise use of leisure by applying scientific principles to the solution of the problems of the increased leisure time available for activity. Programmes could be developed which analyse the community's use of leisure time; the extent and impact of television watching; the biology of relaxation; the utilization of natural resources for leisure; the impact of tourism and so on. At all times the aim should be to focus school science on a meaningful out-of-school life situation so as to ensure an equitable and balanced use of leisure time with a minimal adverse impact on the natural environment.

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5. PROBLEMS AND PROSPECTS OF POPULARISING SCIENCE AND TECHNOLOGY THROUGH NON-SCHOOL ACTIVITIES — SOME THOUGHTS ON THE AFRICAN SITUATION

Michael Atchia
Mauritius Institute of Education
Reduit
Mauritius

Classification

Four types of educational activities of a community are recognisable on the basis of the degree of relationship of the activity with schools:

a. Formal education activities, that is schooling.

b. Educational activities of school-based pupils performed out-of-school, namely out-of-school education.

c. Educational activities of school-based pupils which fall outside the formal curricula, that is extra-curricular activities – some of which may be out-of-school.

d. Traditional or modern, formal, non-formal or informal educational activities unlinked to the schools system i.e. non-school education.

The African scene

In a context where man, especially rural man in Africa, possesses a culture, a wisdom, living traditions and, specially important to us here, a set of appropriate technologies, the development of the non-formal, non-school sector of education acquires vital importance.

In a set-up such as this where schooling is not yet available, everything is transmitted from generation to generation through well-oiled community methods. When schooling has been available, it is undeniable that, especially in the past, profound differences have existed between the knowledge and mode of life of the rural man in Africa or Asia and the knowledge and mode of life given and encouraged by schools. These differences were minimised in such rare set-ups as the Mayflower school experiment of Tai Solarin in Nigeria but on the whole they remained profound wherever schooling was western, colonial or missionary. The disparity between community and school still exists in the following situations:

a. Where in-depth educational reform has not yet been carried out.

b. Where schooling is very recent, leaving a generation gap between 'unschooled' parents and 'schooled' children. Note – an important distinction implied here between 'schooled' and 'educated'.

c. Within individuals themselves where interior conflict may exist between what is

local, African and indigenous and what is western, imported and sometimes imposed.

The integration of cultures

It is only with 'integration' that the paradoxes stated above will gradually disappear and man will recover his integrity and equilibrium.

The process that is suggested here could be termed (negatively) the decolonisation of education or (positively) the integration of cultures. The term "culture" is used here to mean "mode of life" that is integration of the various modes available to man in Africa today – the traditional, the appropriate, the western, the scientific, the religious, the mythological and so on. Such integration of cultures would need, on the one hand, a very close collaboration between school and community and, on the other hand, the development and enhancement of non-school activities.

Non-school education

The formal, non-formal or informal activities referred to here and directed at members of a community, of all ages and occupations and are aimed at answering community needs.

Non-school education should, in the years to come, concern an increasing not decreasing number of people, youth and adults alike, because of the inappropriateness of vast sections of formal school education in Africa.

The success and the methodology of traditional and modern non-school education could influence considerably the evolution of the school system in Africa, to lead eventually to a new African education that will be not only all embracing but take into consideration jointly, the nature of the African and Africa and the type of society we want. For example, to cite Nigeria again, a giant reform such as Nigerian UPE (Universal Primary Education) will not be successful so long as its content and pedagogy does not resolve the problem of integration of cultures as defined above.

Advantages of non-school education in Africa

It is possible to identify several clear-cut advantages of non-school education in Africa. Some are listed below.

a. It is open to all, non-selective and not competitive; this represents a considerable advantage in our countries where excessive competition at all levels exists.

b. Non-school education can be continuous and life-long; it is thus a great advantage in countries where only a proportion of people from a narrow age-range (5-13 years) have access to formal schooling.

c. Because it requires fewer buildings, administrators, equipment and so on, making use of existing community facilities non-school education can be considerably cheaper.

d. It does not suffer from the isolation and for that matter the alienation from society and the environment which is the case for many a school; ideally informal education takes place during everyday life in the community and thus fulfils an essential function of education, namely the development of the individual and his community within their given environment.

e. From the point of view of research, non-school education is still open-ended and unfettered by some of the rigid structures which govern school and university life in Africa and elsewhere.

f. Rapid changes in society such as industrialisation, degradation of the environment, population explosions, political upheavals and so on are not immediately translated into formal school and university curricula; these changes are often the very reason for the development of non-school education through which the integration of the old and the new can occur.

g. Traditional and modern science and technology of an appropriate nature are the very bases of the mode of life of people, much more so than theoretical or philosophical knowledge, hence the need for non-school education to concern itself with the former fields.

The western-type school, unreformed, has been much more at the service of those in power than it has been an instrument of integration of cultures and development of the masses. While waiting for in-depth reform of educational systems where this is not yet taking place, a good strategy for progress would be to turn one's attention to the non-school sector.

What to popularise?

Modern science and technology in its entirety should not, in my view, become the subjects of non-school education in Africa. The main criteria for the choice of content should be appropriateness to the specific community and ability to contribute to improving quality of life. For example, topics such as the following, already part of the formal school curriculum, should not be taught in the informal sector.

Structure of the atom (Chemistry)
Origin of species and classification (Biology)
Radioactivity and Thermodynamics (Physics)
Organ transplants, lasers, communication satellites (Technology)

It is important here to note that in no way is one saying that Africa or Asia should not rise to the heights of achievement in science and technology. It is simply that lifelong education, informal education, and hence non-school education, have a different vocation.

With thinkers such as Rene Dumont, E Schumacher, Simon Watt, P O Ngoddy, J C Hazera, J Nyerere, one must recognise the nature of *endogenous development* or *self reliance*. A given technology can only be assessed in a physico-socio-cultural context, not on its own.

The method developed by the Commission for Education of the International Union of Biological Sciences (IUBS) particularly the work of Schaefer, Kelly, Hernandez and Atchia has shown how the needs of a community can be met through appropriate educational programmes.

After having listed examples of topics to be avoided in non-school education, here now is a tentative list of 'suitable' topics that is topics appropriate to a given community and environment:

Population, population control, habitat, appropriate architecture, health, modern and traditional medicine, nutrition, diet, food preparation, agriculture, irrigation, soil erosion, improvement of agricultural techniques, natural resources, ecology, rational exploitation of resources, conservation and respect for nature, biological equilibrium, the social environment, socio-politico-cultural structure of communities, industrialisation, small-scale industries, elementary economics, nature and natural cycles, the correct use and maintenance of the products of modern technology, self-reliance.

How to popularise?

Modern educational methods which need not be described here all have their roles to play: use of posters, talks in civic centres, use of radio, T.V., press and so on. The special contribution of this paper is to propose a new method:

> Science and technology need not be popularised through the teaching of theory nor through the blackboard, the written word or the diagram. Using both traditional and modern pedagogy, **POPULARISATION CAN BE ACHIEVED THROUGH DEMONSTRATION AND UTILISATION OF APPROPRIATE TECHNOLOGIES WITHIN THE LIVING COMMUNITY ITSELF.**

This last sentence summarises the essential message of this article – it defines both the main objective and the appropriate methodology of non-school education.

Example of appropriate technology

'Maziara jars' have been utilised in Egypt and elsewhere for thousands of years. Placed in an air-current, the evaporation of water is used to cool houses. Made of porous clay, the 'maziara jars' are self-regulated, losing more water by evaporation the hotter it is; they utilise no energy except the human hands necessary to fill them up.

Non-school education based on this example could include the making of these jars and their experimental utilisation in the homes of volunteers and eventually in everyone else's home. This example would be utilisable in hot, dry climates where river water is available. Further developments would consist of the scientific explanation of latent heat of evaporation, of modification of the architecture of houses to create air currents to make these jars efficient, of comparative studies of the cost of different methods of cooling houses and so on.

Other techniques which could be utilised in a similar way are: the Indian method of cooling a house (a Khush-khush mat made of plaited grass hung at windows and kept moist); the Indian fridge (illustrated); the solar water heater (utilised in Kenya, Botswana, Zimbabwe, South Africa), the Ngoddy gari-mill (now produced by a Nigerian firm), and the small-scale solar desalination plant.

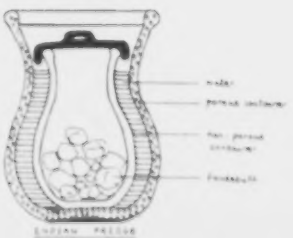

Fig. 1. A simple Indian refrigerator – an example of effective traditional technology.

In fact, any one suitable technique which answers a community need may be utilised to set the ball rolling. There is no end to the extent at which non-school education can help a community improve the quality of life of its members.

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6. THE CONTINUING PROFESSIONAL DEVELOPMENT OF SCHOOL TEACHERS FOR OUT-OF-SCHOOL SCIENCE ACTIVITIES

G. Rex Meyer
School of Education
Macquarie University
North Ryde, New South Wales 2113
Australia

In recent years there has been a world-wide increase in interest in out-of-school science activities. This development has occurred in the formal, non-formal and informal sectors. By the *formal* system is meant the more traditional "main-stream" programme of schools, colleges, polytechnics, universities and other formally constituted institutions. In the formal sector the trend has been to relate conventional classroom science to more socially and environmentally directed "out-of-school" activity. By *non-formal* education is meant systems established in many countries to provide "catch-up" programmes, usually for adults who have for some reason missed out on basic skills. Non-formal programmes prepare people to re-enter the formal system at a predetermined point, say at the beginning of Senior High School or at the freshman year of College. Non-formal programmes usually begin from an out-of-school base – frequently starting with an "on-job" orientation attempting to link "in-school" and "out-of-school" science in an interrelated conceptual system. By *informal* education is meant the vast array of community-based learning experiences emerging in all countries within industry, government departments, commerce, health, general education and so on. Many of these informal programmes are science-based. They are certainly out-of-school and have their own objectives and strategies.

Much as the non-formal and informal sectors are of great interest and significance, but this article because of space constraints, has had to restrict discussion to out-of-school science in the formal sector and more specifically to out-of-school science activities arranged by primary and secondary schools.

Types of out-of-school science activities in the formal sector

One trend now well developed in many countries has been the development of networks of field centres and environmental studies classrooms. Frequently these are permanently staffed by teachers, many of whom are seconded from government schools. Most offer rigorous programmes of out-of-doors education in a variety of subjects at all levels – including science. Joan Webb, in a recently published survey of these centres in Australia, reported that in 1980, 38 were functioning in New South Wales; 23 in South Australia; 18 in Tasmania; 22 in Victoria and 6 in Western Australia: a total of 130 for the six Australian States. (Webb, 1980). This pattern is typical of many countries – see for example the article by Professor Gornall in Part III. Field and Environmental Centres offer schools an opportunity to study ecology, conservation, natural history and related subjects in both natural and man-made environments.

A second trend has been the development of special programmes by trained educa-

tional field officers or consultants attached to regional or provincial offices of education throughout a country or State. These people are appointed as education officers to museums, botanical gardens, zoos, scientific installations, permanent industrial exhibitions and so on. Their programmes are usually available in three ways – firstly by organizing exhibits and displays for use by pupils coming on unstructured visits; secondly by providing lesson materials for use by pupils attending with or without a teacher and thirdly by direct teaching of visiting classes.

A third trend is to link out-of-school science activities with camping, sporting and other recreational activities and again Professor Gornall's article is of relevance (see Part III). In many countries government Departments of Education provide sporting and recreational centres. While not all may be permanently staffed or equipped, and while their main focus is usually on physical and social education and recreation, such centres do provide opportunities for science-based activities. Some of these activities may emerge as the main purpose of a school visit while others may be additional or even elective activities associated with a sporting or other recreational programme.

A fourth trend is for national curriculum centres to produce science materials designed mainly for use out-of-school. National programmes such as Nuffield Biology in the United Kingdom, the Biological Sciences Curriculum Study in the United States, The Australian Science Education Project and The Australian Environmental Education Project are good examples. These and similar national projects produce books of learning activities, field guides and other materials that can be used out-of-school.

A fifth trend has been a rapid world-wide expansion of inservice education over the past decade. In most school systems inservice is now seen much more broadly and not just as retraining for the introduction of a new syllabus. A key focus has been to provide at national, state and provincial levels, programmes which help teachers develop the special skills needed for teaching out-of-school science.

A sixth development has been an increased concern for giving school pupils some work experience. Countries such as Czechoslovakia have for many years focussed on integrating academic learning in school with real work experience out-of-school. Other countries are now benefitting from the pioneer work.

For example, most Australian school systems now provide for up to two weeks a year for students in school years 9 and 10 to engage in some work experience. Employers in industry, educational institutions, farms, forests, and research institutions give young people a chance to experience a little of the world of work. Pupils can and do frequently select work with a scientific basis. While this is rarely structured or supervised by the school it does give some opportunity for pupils to experience real life science in a non-school setting.

A seventh trend is also world-wide. It is reflected in a growing interest in school-community programmes. More traditionally the community has used school facilities as a base for various activities such as evening college hobby classes, language schools and recreational clubs, but more recently the school itself has become more outward looking. In the 1960s and 1970s a few schools were established entirely as community schools – schools without walls. These schools used halls, libraries, parklands, industrial sites, museums, and the like and did not have any buildings of their own. More frequently, however, programmes developed by conventional schools, have come to perceive the community as a rich and varied resource for all subjects of the curriculum, including, of course, science. Programmes of visits and inspections to various community sites are now an accepted feature of education in most countries and many of these are science-based.

An eighth and final trend requires special mention and special commendation. It is

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the work of Science Teachers' Associations world-wide. Such associations have long promoted out-of-school science activities by sponsoring conferences, displays, training programmes, field excursions, science fairs, school science research projects and so on. Science Teachers' Associations have also forged strong bonds between pupil and teacher in non-conventional settings. They have, therefore, made and continue to make most valuable contributions to out-of-school science programmes.

Problems of out-of-school science

While the previous discussion has shown that out-of-school science is generally well developed there do remain some key problems. The main difficulties arise because various out-of-school opportunities in most countries while richly varied, are often fragmentary, unco-ordinated and frequently parochial. They tend to offer highly specific programmes determined by the particular resources at hand (for example opportunities provided by a specific zoo or museum collection, a display or a defined field area); by the issues of their particular speciality (conservation or production of a certain chemical or mineral for example), and by the interests and skills of the staff in charge of the programmes. Out-of-school programmes sponsored by outside agencies have something to sell and usually sell it very well. But this leads to an emphasis on the development of specific packages for pupils rather than on the training of teachers in the generalised skills needed for organising out-of-school activities. So teachers tend to become dependent on the specific offerings of the various out-of-school agencies and frequently fail to develop programmes and resources of their own. This in turn leads to severe problems of disjunction between out-of-school and within school activities, and the out-of-school experiences become isolated and *ad hoc*, lacking smooth integration with the on-going, unfolding learning programme of the school.

Failure in integration is frequently aggravated by lack of continuous access to specific out-of-school programmes. In the Australian State of New South Wales, for example, there are less than ten science museum, zoo and botanical garden educational services for the whole State, and the waiting time for a class visit may be many months. This time lag naturally distorts the school programme and makes smooth integration very difficult. But even long waiting times cannot solve the more severe problem of an overall shortfall in resources. Joan Webb in her survey of field studies centres in Australia, comments that in 1978 only 6.1% of pupils in Queensland and 2.2% of those in New South Wales had managed one visit to a field centre in the course of the year. This is not at all surprising when it is noted that in 1978 there were 439,964 pupils in Queensland schools competing for access to only eleven field centres and 1,032,919 in New South Wales served by only nine centres. (Webb, 1980, p. 109).

Partial solutions in Australia

Fortunately these problems have been recognised by many teachers on both the school and non-school side, and there are the beginnings of programmes which place emphasis on continuing professional development of the classroom teacher, attempting to free him or her from total dependence on specific activities and resources, and especially from is devised to suit the needs and interests of each specific class. (Martin, 1980).

One type of partial solution has been found by many out-of-school facilities which now provide some kind of orientation programme for teachers intending to use the facility. As a minimum this takes the form of printed materials describing the objectives, programmes and facilities available and advising on pre-visit class preparation and follow-up lessons. At best they are organised as voluntary or compulsory on-site seminars. In Australia The Marine Studies Centre at Woodbridge, Tasmania, for example, provides a one day orientation seminar for primary and secondary teachers on seven specified

dates of the year and any teacher intending to take pupils to the Centre must attend this seminar. During the seminar activities are demonstrated and discussed and a programme is devised to suit the needs and interests of each specific class. (Martin , 1980).

These types of orientation programme only go part of the way. They do help to make the experience 'fit' the school programme, but it is the school programme which must adapt, not the out-of-school activity. Even when activities are selected to meet the needs of a particular class they are usually chosen from the limited repertoire provided by the staff of the out-of-school facility, and so the match is not exact and there is an inevitable distortion of the school programme. This model also implies that a conscientious teacher must attend a specific orientation day for each of the many 'new' out-of-school facilities he or she might like to utilise throughout the school year – a rather limiting and restricting demand, at least for facilities being visited for the first time. This approach also totally fails to solve the problem of the absolute shortage of resources due to the inadequate numbers of fully staffed and serviced out-of-school facilities in the country as a whole.

A slightly more effective approach has been adopted by some centres. This involves the training of teachers in the general skills of out-of-school teaching through the design and production of suitable learning resources. A good example of this, again from Australia, is the series of two-day workshops for teachers provided by the Brewongle Field Studies Centre at Sackville North in New South Wales. Teachers are given a suggested list of environmental topics for lesson development. A recent course at Brewongle offered the following topics, mostly with a science orientation.

1. History all around you
2. Project learning tree
3. "Soils are not just soils"
4. Farming along the Hawkesbury River
5. Role playing
6. Art and craft in the bush
7. Trees : a natural factory
8. Mini trails
9. Birds – our feathered friends
10. Energy conservation

Teachers selected a topic and developed environmental units which could be used either at the Field Studies Centre, in the school grounds or in an area near the school. The resource units were developed using the following standardised headings:

Title
Introduction
Aims and objectives
Age group
Pre-visit activities
Resources
Unit activities
Conclusion
Follow-up materials

The units were written on stencils and copies of all units were shared. (Bowden, 1981).

This model has the disadvantage, however, of requiring teachers to withdraw from school and to visit the centre concerned for up to two days at a time. It has the further disadvantage that even though an attempt is made to 'free' the teacher from the specifics of a particular centre all the input comes from that centre and the resources produced are frequently linked to that situation. As an alternative, an extension of the model has been developed by some centres. The staff gives a fixed proportion of time to attend

conferences and to visit schools for talks and workshops. This idea is further extended by some agencies which provide a one-to-one consultancy service. This may be for all aspects of science teaching or specifically for out-of-school science. Almost all government regional offices of education in each Australian State, for example, employ science education consultants and most include consultancy on field work, and on general aspects of out-of-school activities. Some tertiary educational institutions also provide consultancy services. In Queensland, the Department of Liberal Studies of the North Brisbane College of Advanced Education offers consultancy advice for primary level teachers intending to set up field study or environmental study centres or who wish to conduct outdoor activities such as excursions or astronomy evenings. The College science staff also advise on the planning and conduct of out-of-school activities for a selected group of schools in the region and advise on the use of specialised equipment for out-of-school activities, in some instances actually supplying the equipment on loan. (Ginns, 1981). Some colleges of advanced education offer more formal programmes for qualified teachers, as contributions to their professional inservice development. The Adelaide College of the Arts in South Australia, for example, offers a Bachelor of Education Degree (Inservice) in field science as well as an informal series of Urban Natural History Fairs. In Queensland, the Kelvin Grove College of Advanced Education (now the Brisbane College of Advanced Education) provides a specialised graduate diploma in Outdoor Education and this has a strong field science emphasis.

Various programmes of continuing professional development, whether on site, within school, through consultancy services or through course work, attempt to cater for specific aspects of the diverse objectives of the varied out-of-school science activities. But they too are frequently *ad hoc* and there has been little or no attempt by any organisation or agency, either preservice or inservice, to identify the overall objectives of the out-of-school movement and to cater for them in a systematic way. Part of the reason for this is that the objectives, appear at first inspection, to be too diverse to allow for any common approach through inservice education. And this view is correct if the objectives are expressed in terms of the specific knowledge, skills and attitudes to be gained from any *particular* experience – say from a study of stream ecology or of the strata of a forest; from the analysis of an industrial process or from a pupil's first encounter with the world of work.

A general solution – professional staff development

As we have seen, part of the difficulty of developing a coherent programme of professional development for science teachers to prepare them for out-of-school teaching, is that the specific objectives of the various types of activities are very diverse. If however, aims and objectives of the varied forms of out-of-school science activities are defined more generally, then a great deal can be done by means of continuing education programmes. Teachers can be given the generalised skills required to organise and implement these types of activity.

An analysis of various programmes of field study, environmental education, community involvement, work experience and so on world-wide, tends to show that almost all try to achieve the following types of aims.

It is possible to see how these aims could be made operational by specifying a set of general objectives which would contribute to their development. It is also easy to see that more specific objectives could be prepared for any particular out-of-school activity which would contribute to the general objectives and hence to the aims.

So an out-of-school science activity comes down to the effective utilization of a resource for the achievement of specified objectives, which in turn must be seen in two

ways, firstly as contributing to the general aims of the out-of-school ideal, and secondly as contributing to the unfolding and ongoing science programme of the school.

With this type of approach in mind it is not difficult to visualize emerging, some across-the-board systematic professional development programme for teachers designed to give them knowledge, skills and attitudes necessary for the effective organisation and implementation of out-of-school science activities.

Aims of Out-of-School Science

1. Extend pupils' horizon and experiences by involving them in a wider range of activities than they would encounter at home or school;
2. make schooling more relevant to the real world by involving pupils in activities on site in the community and in the natural environment;
3. train pupils in the skills of solving problems in real life settings through processes such as observation, record keeping, analysis, interpretation and evaluation;
4. introduce pupils to features of his or her local environmental, natural and cultural, both as it is in the present and as it was in the past;
5. develop in pupils an understanding of how mankind is managing resources – both in terms of effective use and misuse;
6. develop the social and physical skills of pupils in natural and cultural settings away from the contrived social climate of the school;
7. develop in pupils the ability to make meaningful decisions about the quality of the environment and on a desired life style for themselves personally and the community at large;
8. develop positive attitudes and to hold appropriate values about the natural and man-made environment;
9. develop both understanding and appreciation of an individual's roles in both natural and man-made environments for the maintenance of a satisfactory quality of life;
10. develop in pupils the point of view that the environment, be it natural bushland, an urban setting, the home, the school, the place of employment or whatever, is a resource for learning providing opportunities for personal growth and development.

Teaching competencies needed for out-of-school science

A programme of staff development for out-of-school science would need to develop the following types of general teaching abilities or competencies.

Firstly, teachers would need to undertake *situational analyses*, that is, they should be able to observe any previously unseen situation perhaps a patch of bushland; a fresh-water stream; a forested area; a suburban block; a garbage dump; an assembly line in a factory; a series of radio broadcasts or newspaper comic strips, etc. and break this situation into its major elements (components) and its sub-elements – listing these in logical, hierarchical order. An analysis of the relationships between the elements should lead to the development of possible causal pathways and interacting flow charts should be drawn up to illustrate these. During this phase teachers may need to consult people who are more familiar with the particular situation, or else undertake a little library research.

Secondly, teachers would need to *appraise the results of the situational analysis in terms of potential educational outcomes* suitable for and relevant to the needs of a

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defined group of pupils. This aspect is particularly subtle as it requires a selection of outcomes not only suitable for the pupils involved, but which also correlate and integrate with intended outcomes of the science curriculum of the school. As this is essentially an exercise in curriculum development, and especially in curriculum integration, teachers would need to have a good understanding of the general principles of curriculum construction. Thirdly, the selected *outcomes should be expressed as a set of general aims, and operationalised into a broad statement of general objectives.* Teachers should, therefore, be competent in the process of translating science 'content' or 'concept' statements into operational objectives, and this ability needs to be developed in the special context of out-of-school experience.

From this point the skills are as for any other learning unit. *Science content should be selected and arranged* in learning sequences in a way that will lead to the achievement of the previously defined outcomes. *Strategies should be devised* which would enable each phase of the sequence to contribute effectively to these learning outcomes, and *assessment procedures should be developed* to check on achievement. The whole process should be fluid and interactive so that the total learning sequence is revised as each phase of development proceeds. The trialling, evaluation and *final implementation* of the units of work would be the same as for any other type of learning sequence.

So the organisation and implementation of out-of-school science activities comes down to a particular type of resource development and utilisation – or a special aspect of instructional design. The point of special difficulty is at the initial stage of situational analysis, but once teachers have attempted this in several contrasted but relatively familiar settings, they quickly gain confidence and are prepared to extend into quite unknown areas of the natural and man-made world.

Implementing staff development

The question remains how should such a staff development programme be organized and how should the required competencies be developed?

A first step should be self diagnosis by all science teachers likely to be involved in organizing out-of-school science activities – and ideally that should be *all* science teachers employed at all levels of a particular school system. One approach is to encourage science teachers to complete a self-evaluative inventory of the type shown on the following pages.

A SELF EVALUATIVE CHECKLIST OF THE COMPETENCIES REQUIRED FOR THE DEVELOPMENT AND IMPLEMENTATION OF OUT-OF-SCHOOL SCIENCE ACTIVITIES

On the following pages is a list of twenty tasks or competencies required for the effective development of a unit of work based on an out-of-school science experience. These have been grouped into four categories. The columns headed 3, 2 1 and 0 are for rating your degree of confidence in undertaking each task. Opposite each statement put a cross in the colum which best matches the level of confidence you have in undertaking the task. The rating scale is as follows:

3 = highly confident

2 = adequate level of confidence

1 = not very confident

0 = no confidence

Plot your profiles for each of the five categories by joining the crosses with straight lines.

A low rating (1 or 0) suggest you may need to work out a programme of professional development in this area.

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Task/Competency	Level of confidence			
	3	2	1	0
I. Situational Analysis				
1. Identify a range of situations in the natural and man-made environment suitable as resources for out-of-school science activities				
2. Observe each situation perceiving it as a total system of interacting processes				
3. With help from an authority, identify the main elements and sub-elements constituting the situation				
4. With help from an authority, identify and describe some interactive processes operating in the situation				
5. Draw up flow charts or chains of cause and effect to show how the selected processes may interact				
II Curriculum Integration				
6. Select from the elements and processes those illustrating scientific concepts of relevance to the pupils for whom you are responsible				
7. From the situational analysis derive a list of educational outcomes appropriate for your pupils and which correlate and integrate with the intended outcomes of your school science programme				
8. Express the selected science outcomes as a broadly stated list of aims				
9. Develop and list operational objectives expressed in general behavioural terms for a unit or units of work.				
10. Develop a list of specific behavioural objectives for various sub-units of work as required and as appropriate . . .				

Task/Competency	Level of confidence			
	3	2	1	0
III Resource Development				
11. Select and sequence into a learning hierarchy, those scientific concepts derived from the situational analysis integrated with concepts from the school science programme which contribute to the aims and objectives of the unit/s of work				
12. Select, sequence and develop learning experiences appropriate for each phase of the concept sequence				
13. Design assessment procedures for appropriate phases of the learning sequence to check on the progressive achievement of the objectives				
14. Trial and evaluate a draft of the unit/s. .				
15. Produce a final version of the units ready for use in the school and in the out-of-school situation				
IV. Implementation				
16. Organise and present effective preparatory lessons before visiting the out-of-school site				
17. Organise all administrative details (e.g. permissions, transport, finances resources, etc.) for a visit away from the school				
18. Lead a class on an excursion/s away from the school while continuing to maintain an effective learning climate				
19. Effectively implement a sequence of learning activities especially developed for the out-of-school situation				
20. When back at school organise and present follow-up lessons which fully integrate the experience into the mainstream science programme.				

All competencies identified as being poorly developed – at least in terms of levels of personal confidence – should be listed and a plan of action organized to develop them. This sounds something of a challenge but on the whole teachers, and especially science teachers, are well educated, dedicated and highly motivated professional people. If they can teach others then surely they can teach themselves. Once weaknesses in professionalism have been self-diagnosed, improvement plans can be drawn up drawing on all types of resources. These may include the special knowledge provided by consultants; requests for an especially designed centrally organized, inservice activity; a reading programme; talks with experts and local authorities and so on.

As an example let us suppose that a certain science teacher in a rural school in a tropical country feels uncertain about, say, his or her competency to observe and analyse the elements of an interacting system in a previously unseen out-of-school situation (item 2 on the rating inventory). Considerable benefit could emerge from a general course or a programme of reading on systems theory. The teacher could learn to identify input, processing and output elements of any system and see how they interrelate. Similarly help could be obtained in the general principles of drawing flow charts (item 5) and so on.

Conclusion

Only by following this type of general procedure may science teachers develop overall competencies and attain the total confidence necessary for effective out-of-school science teaching. Teachers need to develop a "do it yourself" attitude to the teaching challenge and so avoid a tendency to depend on the services of experts located at out-of-school teaching sites. That is not to say that such experts are redundant – on the contrary. Their role becomes that of an equal teaching partner – a member of a teaching team. The local expert or specialized teacher assigned for duty at places such as museums, zoos or industrial installations, should provide the expert back-up needed by the classroom teacher, but it is the latter who should take ultimate responsibility for the lessons. Only then will the out-of-school science activity truly relate to the needs of pupils and arise naturally and logically out of the regular learning programme of the school.

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THREE

SELECTED REGIONAL TRENDS AND CASE STUDIES

7. DEVELOPMENT OF OUT-OF-SCHOOL ACTIVITIES IN SCIENCE EDUCATION IN JORDAN

Elias A-H. Baydoun*
Department of Education
Yarmouk University
Irbid., Jordan

Science in Jordan is taught as a separate subject starting from the primary school (grades 1-6) up to the upper secondary level (to grade 12). In its broader aspects, science education is also implemented through Environmental Education and Professional (Vocational) programmes. In the *Environmental Education* programme there is, however, no separate textbook at any educational stage dealing with environmental education. Topics related to environment are covered through a variety of subjects such as geography, biology, general science, physical science and so on. *Professional (Vocational) Education* is treated as a separate subject from grade 1 up to grade 12. Although the curriculum for professional education has been in operation in schools for about five years, no textbook is available as yet. The curriculm for each grade includes several units (4-7) covering biological, chemical, agricultural, medical, physical and environmental aspects, and includes training in handicrafts, embroidery, tree pruning, soil fertilising, electrical work and first aid.

In planning for science teaching, the Ministry of Education is doing its best to apply Bloom's three domains of learning – the cognitive, affective and psycho-motor domains. This is usually accomplished through workshops, crash programmes, seminars, and short courses for teachers, supervisors and head teachers.

Aims of out-of-school science

The overall science education programme focuses on the importance of out-of-school activities. Such activities start at the school level as out-of-class lessons mainly in the school grounds, and expand to include the house, the town, the total community and even the whole country. Learning activities include writing reports, collecting materials, producing handicrafts, participating in scientific field trips, field camps, making observation, studying information media, and being involved in scientific clubs, committees and exhibitions. The broad aims of such activities can be summarized as follows:–

1. Enrichment of the science education programmes.
2. Perception and implementation of scientific concepts.
3. The study of ecosystems, with special stress on environmental problems.
4. Attainment of social skills.
5. Encouraging students to think scientifically and to apply the scientific method to problems.

These aims have recently been taken into consideration by the Ministry of Education. Their achievement, however, faces several obstacles.

* *Acknowledgements are due to Dr. T. Mare of the Department of Education, Yarmouk University, for discussing and reviewing the manuscript.*

Problems of achieving the aims

It is possible to classify problems of achieving the aim of out-of-school science in Jordan in the following way:

A. Problems related to the teacher himself or herself –

1. Lack of knowledge and skill related to out-of-school activities.
2. Lack of motivation and drive to stimulate students to perform activities outside the classroom.
3. Lack of continuing professional development, which is very important in increasing the teacher's knowledge about new trends in science education.
4. Teacher education
   a. Curricula and programmes for teacher education (pre-service, in-service and short courses) do not emphasize the importance of out-of-school activities, knowledge, skills and attitudes.
   b. Although most university graduates eventually become school teachers, their education at the university stresses lectures and laboratory work, while lacking out-of-lecture-room activities.

B. Problems related to the curriculum –

1. Although the syllabus includes certain out-of-school activities, the textbooks do not reflect the importance of these activities. They are treated as secondary issues only.
2. No separate teachers' or students' guide is available for out-of-school activities at any grade level. The Ministry of Education has assigned a proportion of 30% of the evaluation of students in all courses for out-of-school activities. However, teachers usually replace this proportion of the marks by exams, and occasionally by reports.
3. All exams, including general exams set by the Ministry of Education, concentrate on knowledge only and neglect activities.

In addition to these problems, other problems include lack of facilities, equipment, time and research into ways of remedying the situation.

Solving the problems

The question that arises now is: how to solve these problems? Four approaches are being actively pursued in Jordan.

In the first place there is a growing awareness of the urgent need to establish a *National Council for Science Education and Teaching and a Research and Development Center for Science Education* or a *Technical Committee*. These organizations should include experts from the Ministry of Education, the Universities and the Community Colleges. Among the duties of such organizations would be the following:

1. To conduct a survey study of the present situation in out-of-school activities in Jordan. The purpose of this study would be to find out the extent of teachers' knowledge about these activities and how they practice them. This survey could be carried out by means of questionnaires directed to teachers and students. These questionnaires would aim to discover how teachers and students view their present out-of-school activities. A small number of school visits by members of the council or independent observers would be needed to check how well the answers to the questionnaires corresponded with reality. This is needed in view

of the tendency of questionnaires to produce over-optimistic answers especially in a climate of new development.

This process of questionnaires and visits should be repeated periodically to determine progress made in improving out-of-school activities.

2. To produce teachers' and students' guides for out-of-school activities to accompany all textbooks used in education. These guides would provide suggestions for out-of-school activities to complement all the topics covered in the textbooks.
3. To modify the present curriculum and syllabus to emphasize the importance of out-of-school activities, especially those activities related to the immediate environment in which the student lives. The curriculum should be designed to stimulate the student's interest in out-of-school activities.
4. To modify the style of teaching in the Universities and Community Colleges, to stress out-of-school activities, especially for those students likely to become teachers.
5. To develop through teachers' education programmes (pre-service, in-service and short courses) the knowledge and skills needed for out-of-school activities.
6. To ensure that the 30% of the assessment at present allocated by the Ministry of Education for out-of-school activities is in practice used to assess these activities. Supervisors and head teachers should take responsibility for ensuring that this occurs.
7. To encourage the exchange of experience between developed countries and developing ones. Such exchange would help in enriching our curriculum with innovative out-of-school activities.

Secondly, attempts to individualize science learning should be tested as a new approach to learning. Individualization is based on self-learning, self-evaluation, summative evaluation, formative evaluation, inquiry through written words and the stating of behavioural objects. It is evident that these aspects will not limit the student in time and space; on the contrary they will expand and stimulate his or her interests in out-of-school activities. Preliminary studies conducted at Yarmouk University in Jordan to test the effectiveness of programmed-instruction, modular and package methods in learning science have shown that these methods are more effective and productive compared with traditional methods.

In the third place, teachers' education, pre-service and in-service, which in Jordan is still largely based on the theoretical side of knowledge, should now be geared towards education for Competency. That is, there should be Competency/Performance-Based Teacher Education (C-PBTE). As this approach stresses the importance of practical aspects, skills and the statement of behavioural objectives in an effective and efficient manner, it will increase the abilities of the teachers in practising out-of-school activities rather than in merely learning about them.

Fourthly, if inquiry and discovery methods are used to develop the ability of the students to think, this will inevitably increase their creativity when practising out-of-school activities.

To sum up, whatever the suggestions and recommendations may be, the problem should be faced and dealt with through a systems analysis and the systems approach, linked to Competency-based Teacher Education and an inquiry learning orientation in the curriculum. There is every confidence that these approaches will continue to develop in Jordan and that of out-of-school science will continue to be seen as meeting a major educational need.

8. A CHECKLIST OF OUT-OF-SCHOOL SCIENCE ACTIVITIES IN KUWAIT

M. S. Subbarini and A.R. Kablaoui
Ministry of Education
Kuwait

Modern civilization is the civilization of science. One of the main objectives of science curricula in Kuwait is to help pupils adopt the philosophy of science.

Science is mainly a way of thinking and explaining the environment and the universe. In Kuwait science teaching aims to train pupils to behave as scientists by helping them to discover what scientists have already discovered. This is why science curricula in Kuwait emphasize the "Scientific Method" and why science education encourages scientific research and orients it towards problem solving.

Curricula in Kuwait, therefore, aim at providing pupils with basic concepts, attitudes, and skills that form the foundation of a sound training in science.

Types of out-of-school activities in Kuwait

In Kuwait school pupils conduct numerous activities, under the guidance of teachers outside classrooms. These activities include the following:

Young researchers' activities: This is a programme at the elementary level and consists of the following:

i) Collection of samples or photographs.

ii) Simple scientific experiments like planting seeds, animal reproduction by eggs, watching stars, and so on.

iii) Building some toys related to the curricula (for example, magnetic toys, paper fans, simple musical instruments).

Visits: These visits aim on one hand to strengthen the relation between science curricula and life, and on the other to make pupils better acquainted with science activities throughout the country. Activities considered include the following:

i) Agricultural research plant

ii) Kuwait's Zoo

iii) Science Museum, and Kuwait's National Museum

iv) Kuwait Institute for Scientific Research

v) Factories, and Kuwait Distillation Stations

Agricultural contest: This is a yearly contest among Kuwait schools aiming at the following:

i) Developing attitudes towards the conservation of the environment

ii) Developing the feeling of beauty among pupils

iii) Developing the spirit of co-operation among pupils

iv) Providing pupils with experience in agriculture

v) Elaborating some of the scientific concepts of the science curricula

Scientific contests: These are yearly contests. They aim to achieve the following:

i) Encouraging scientific research among pupils

ii) Developing skills of scientific thinking among pupils

iii) Developing skills of making scientific instruments

Other activities: Teachers encourage pupils to undertake the following types of activities:

i) Preparing aquaria

ii) Gathering data about some environmental problems (fire, car accidents and so on).

iii) Making scientific models and aids

iv) Writing scientific papers

Other opportunities are also available for pupils as out-of-school activities through the Kuwait Institute for Scientific Research and the Science Club of Kuwait. The *Kuwait Institute for Scientific Research* has a role in training pupils in scientific research through the two summer training courses, one for secondary school pupils and the other for university students. The *Science Club of Kuwait*, gives opportunities for pupils to work on their own through the following activities:

i) Making models

ii) Making scientific, laboratory, home and industrial equipment

iii) Constructing equipment

iv) Scientific research

v) Holding contests among club members.

Evaluative appraisal

The programmes listed above represent the range of out-of-school activities in Kuwait but implementation is somewhat constrained by four main factors.

1. The school timetable is not sufficiently flexible to permit effective implementation.

2. Time allocated for science in the school timetable is too short compared to time allocated for other subjects – see the following table:

School Level	Science (%)	Other Subjects (%)
Primary	8.3	91.7
Intermediate	10.0	90.0
Secondary	25.6	74.4

A comparison between the proportions of time given for science and other subjects in the three levels of general education in schools in Kuwait.

3. There are social restrictions on participation by girls in some of the out-of-school activities, field work in particular.
4. Teachers are not well qualified for implementation of out-of-school activities. This problem has not, until now, been given sufficient serious consideration in pre- and in-service education for teachers.

Future development

Two developments are promising for improving out-of-school activities in science in Kuwait. The *first* is an experiment giving more time for out-of-school activities within the timetable of credit hours in secondary schools. This experiment is on trial now in six schools. The *second* is allocating time for free activity subjects in intermediate schools. In these subjects pupils practise their manual and mental skills both theoretically and experimentally. These subjects can form a clear link with out-of-school science activities.

9. OUT-OF-SCHOOL SCIENCE ACTIVITIES IN MALAYSIA

Siew Yoong Cheong
Faculty of Education
University of Malaysia
Kuala Lumpur, Malaysia

The evolution of the present system of education in Malaysia can be seen to be largely due to the historical and political occurrences in the country. With the passing of the Pioneer Industries Ordinance in 1958 and the implementation of each of the four five-year Malaysia Plans covering the period 1965-1985, Malaysia has entered into an era of rapid development, industrialisation and modernisation. Unprecedented efforts are being made to develop the manpower needs of the country and, more importantly, to promote socio-economic progress so as to raise the quality of life of the people.

It is mainly in the context of the great demand for more people with a scientific training and literacy as well as a critical attitude towards scientific activities that school science education has developed. Since about 1968, the Ministry of Education has initiated a series of reforms to improve the quality of science education in schools. Accordingly, the science curricula have been adjusted and curricular contents renewed so as to make them more in line with contemporary needs.

Patterns and programmes in science education

In Malaysia, education in science has been made compulsory at the primary and secondary levels of formal schooling, that is for year 1-6 (Std. 1-6) at primary level and year 7-11 (Form 1-5) at secondary level.

In primary schools, science is taught as a subject in organized classes that follow regular timetables. Guidebooks produced by the Ministry of Education are available to help teachers implement the objectives of science units, utilize appropriate teaching approaches, direct pupils' activities and evaluate pupils' achievement. The fundamental aim of primary science is have pupils explore into the nature of things based on their curiosity and interest in the environment. Designed to present science as a unitary whole, the course emphasises key concepts related to types of plants and how they adapt to the environment, life cycles of animals and the economic importance of agriculture.

In the lower secondary comprehensive schools, science is taught as integrated science. The Malaysian Integrated Science is an adaptation of the Scottish Integrated Science and was introduced into schools in 1969. The scope of the course if delineated by a syllabus and guide notes prepared by the Ministry to help teachers implement its content. Pupil worksheets provide the guides for laboratory activities, and textbooks written by local authors are also available. The main philosophy of Integrated Science is to cultivate in pupils a spirit of investigation and how to approach problems using the processes of science. It also deals with broad relationships and attempts to link science education with practical application in the outside environment.

At the upper secondary level, four main courses in science are available for choice by students depending on whether they are in the Science or Arts stream. Science stream students normally take the pure subjects – Biology, Chemistry and Physics whilst the Arts students are offered a general science course. The Malaysian curricula – Modern Biology, Modern Chemistry and Modern Physics, are based on the Nuffield "O" Level materials and they have been introduced into schools since 1972. The Malaysian General Science curriculum is an indigenous development and was fully implemented in all schools by 1978. All these curricula have been developed with the main purpose of presenting science to students as a system of conceptual knowledge, as a way of inquiry into the nature of things and as a body of information built up by the enquiries of scientists and other people involved in scientific activities. Accordingly, investigatory exercises form a dominating feature in all these programmes. In terms of content, aside from scientific knowledge, some issues of social importance have also been included, for example depletion of natural resources, pollution, effects of intensive farming and the energy crises. These examples aim to illustrate the application and impact of science and technology on everyday life. To ensure effective implementation, teaching and learning approaches are designed to encourage student activities both in the laboratory as well as outside it.

Notwithstanding the curriculum innovations that have taken place thus far, the Ministry of Education is currently in the throes of initiating further changes to the system of education as recommended by the Cabinet Committee whose Report on Education was published in 1979. The recommendations which focus on general education for all students from year 1-11 have many implications for science education. The emphasis on the 3R's will eventually see the blurring of science as a subject in the primary school. At the secondary level, discussions are being made as to how the existing content-based courses can be liberalised and made more useful to meet the needs of students living in a rapidly changing physical and social environment. Suggestions are being made to infuse into existing secondary science curricula more materials on social problems and issues and these are to be derived from the areas of environmental education, consumer education, drug education, environmental health and safety, energy and population. Clearly, such a direction will require an increasing use of community resources and out-of-school activities for science learning.

Place and aims of out-of-school activities in the overall science education programme

The secondary science courses in Malaysia are heavily material based. Each science curriculum has been developed as a "package" of instructional materials: textbook, teacher's guide and other auxiliary materials, designed to function as an integrated whole. To implement the laboratory programme, the Ministry of Education is making available large grants of money on an annual basis to schools towards the purchase of science equipment and other expendable materials.

However, it has become clear that laboratory based activities are not only costly but restrict the students' practical experience with the natural environments and the development of their skills in carrying out investigations on local problems in the community. This is viewed to be counter-productive to the trend in having science learning more functional, more relevant to life situations and more useful for students.

More so now than before, teachers are increasingly encouraged to diversify their teaching resources, to utilize community opportunities as the contexts to relate scientific knowledge and practical application and to incorporate out-of-school activities as part of their teaching strategies. Consequently, co-curricular science activities are considered to be an important dimension in the overall science education programme.

There are various ways in which out-of-school activities can be conceptualized. For the purpose of this paper they are viewed as those organized learning experiences provided for within the context of educational institutions outside the laboratory and school on a formal as well as non-formal basis. For instance, out-of-school activities in science may be organized for a single session (e.g. a visit to the zoo), for a project over a period of time (e.g. a survey), or as part of a series of lessons on a specific science topic. Therefore, various types of out-of-school activities may be developed for various purposes.

It is thus possible to distinguish two major ways in which out-of-school science has been used in support of school teaching. The first involves the development and integration of such activities within the instructional programme for the teaching of certain areas in the formal curriculum. For example, in the biology course for year 10, an ecological study of a local habitat has been made compulsory for all students. The second from of out-of-school science activity is organized on a non-formal level and normally carried out outside school hours as co-curricular activities. Although these are not determined by course requirements, they nevertheless relate closely to the science learned. To that extent, they are used to complement and supplement the science taught in the formal system.

Broadly speaking out-of-school science activities have been organized with the following aims in mind.

The Aims of Out-of-School Science Activities in Malaysia

(1) Develop environmental awareness so as to provide students with a better understanding of their surroundings and of the relationship of life with them.

(2) Provide students with some knowledge and understanding of the environment, natural as well as man made, through involvement in investigations in real life situations.

(3) Develop students' understanding of the scientific basis of problems and issues in the community and the impact of these on the well-being of the physical and human environments.

(4) Develop a deeper understanding of the practical application of science, such as in industries, agriculture and medicine, for social and national development.

(5) Develop students' higher cognitive skills in solving problems and making decisions through the use of scientific processes in real life situations.

(6) Extend students' scientific knowledge and experiences in aspects of science and technology which are unavailable within the laboratory and school.

(7) Develop healthy attitudes and values toward the use and abuse of environmental resources and to appreciate the contributions of these for the quality of life.

(8) Develop desirable social behaviours – co-operation, sharing, compassion, – among students in outside settings.

(9) Develop a greater motivation and interest in science and scientific activity.

Specific activities and programmes

From the range of out-of-school science programmes developed within the formal system of education, the most significant has been those organized by School Science

Societies. In Malaysia, the formation of Science Societies is undertaken by student groups and, though not compulsory, almost all schools with secondary science classes have one of their own. Science teachers serve as advisors in these societies while the administration and organization of activities are largely the responsibilities of members and the executive committee. Some of the more popular activities of these societies are described briefly below.

1. **Projects**. These can be either long-term or short-term projects. The different kinds of projects are based on the interests of student groups and available resources Examples of projects include laboratory experimental work, surveys of local ecological systems, market studies.
2. **Seminars and talks**. These can be either directly or indirectly related to science. Scientists, applied scientists, industrialists, guidance and counsellors, educationists, experts from private associations and government officials are often invited to participate.
3. **Excursions and visits**. These may be made either to local or out-of-state places. Zoos, museums, industrial plants, factories, agricultural stations and institutions involved in scientific work and research are particularly popular.
4. **Bulletin Board Displays**. Magazine and journal articles, student essays, newspaper clippings and other current developments in science and technology are displayed.
5. **Competitions and contests**. These are mainly quiz, essay and science exhibit competitions organized on an annual basis.
6. **Films and slide shows**. These are no a variety of topics made available by national and international organizations, e.g. British Council, USIS, World Wildlife Fund.
7. **Preparation activities**. Teaching aids e.g. charts, models and apparatus are prepared for teachers' use in formal teaching.

In recent years the Ministry of Education has established a programme of *science exhibitions* for secondary schools. Schools are encouraged to work on projects of scientific and community interest and in particular in social problems and practices in which knowledge can be applied. A National School Science Exhibition is organized state qualify to participate in this exhibition. The judging of the projects take into consideration the originality of the problem and of approach in investigation, the presentation of the display, the usefulness and applicability of the findings and the social impact of the project. Some of the winners in the 1981 National Exhibition dealt with areas such as the following:

- Ill-effects of using calcium carbide for the ripening of fruits
- Effects of sodium glutumate on the development of chickens
- Recycling waste metals
- Electromagnetic trains
- Making an electronic master key

The results of this exhibition are widely advertised and it has become one of the most prestigious and important out-of-school science programmes in Malaysia. Assisted financially by local industries, the sponsors are able to provide attractive prizes, in the form of trophies, cash awards, certificates and commendations to the winning schools.

By far the largest number of out-of-school opportunities for learning science comes

from *outside the formal system of education*. Many professional associations for example, the Malaysian Nature Society and the Science Teachers' Association, have developed materials and programmes which teachers and students can use for their out-of-school activities. The Malaysian Zoological Society has established the Zoo Negara Education Centre whose concern is with the education of youths and adults in wildlife and its conservation. Recently, the Institute of Physics has organized a national science essay competition for school students and the Science Society of the University of Malaya has also conducted a national inter-school science quiz at pre-university level. Institutions of higher learning welcome the use of certain of their outdoor facilities by schools. The Field Study Centre of the University of Malaya which includes a laboratory and hostel accommodation for 30 people has been used for the training of teachers and students in field studies related to ecology and wildlife. The Department of Wildlife and National Parks in co-operation with the Ministry of Education has set up a Nature Study Centre in the midst of one of the largest park reserves in Malaysia. The Centre is an ideal place to study the natural habitats of tropical wildlife, ecological balance, jungle tracking and the variety of flora and fauna in the tropical forest. The Centre's hostel houses about fifty people and during the school holidays special programmes are organized with guide services provided to help students and teachers explore the natural surroundings. Most industrial firms welcome visits by groups of students and many have produced materials on various topics in science. Certain private organizations such as the Consumers Associations, *Friends of the Earth* and the *Environment Protection Society*, are particularly conscious of their role in school and public education. Each of these organizations has its own publication on social issues and problems, as well as produced films and slide sets on particular issue areas for sale or loan. The mass media such as newspapers, radio and television are rich sources of science-related materials and information. The audio-visual materials prepared by Educational Media Services and Educational Television are particularly relevant to science taught in the schools.

Problems in the implementation of out-of-school science activities

Except for those field-based activities which are mandatory as part of school science curriculum packages, out-of-school science activities are, often than not, organized on an *ad hoc* basis and at the discretion of the science staff and students. Although a large number of out-of-school programmes are available, they are unfortunately not often used in support of school science teaching. For the most part teachers are ill informed about many of the out-of-school facilities particularly those outside the administration of the Ministry of Education. Furthermore, most of the opportunities located in urban areas are out of reach of rural teachers and children and vice versa. In cases where there is long distance travelling or exposures to risks, heavy demands are made on the science teachers, and the responsibility for the safety of the students has remained a major deterrent in the organization of field-based science work.

School science societies also face many challenges to maintain an active programme. Funds for activities come mainly from student subscriptions and this sets limits to the frequency of meetings and the type of activities that can be carried out. Furthermore, over-emphasis on cognitive knowledge in examinations has led to a lack of motivation in and poor attendance at society gatherings. The very specific weekly time allocation assigned to each type of co-curricular activity is another constraint experienced by the society.

Obviously, science teachers have a vital role to play in the organization of out-of-school science. In the schools, the scope and quality of the society's activities reflect very much their ideas and resourcefulness in developing a rich programme for their students. Unfortunately, there have been few programmes geared specifically for the

training of teachers in out-of-school activities. At pre-science level, due to pressures of time and funds, not enough attention has hitherto been given to developing teachers' practical skills in organizing out-of-school work as well as how these can be integrated with the formal teaching of science at school Thus the teachers' experience with out-of-school science has been limited to not much beyond what is provided within the science courses at colleges or universities. The problem is aggravated by a lack of printed material, such as procedures for investigating environmental problems to guide teachers in the conduct of out-of-school science activities. There is in general, no recognition for teachers' involvement other than the achievement of self-satisfaction and this has led to low incentives among teachers in organizing out-of-school programmes.

Fortunately, recent awareness about the value of out-of-school science has brought changes to the attitudes of educationists, and greater interest is now shown in preparing teachers to handle out-of-school activities. At the Faculty of Education, University of Malaysia, all method courses include elements of this training and attempts are made to increase the exposures of teachers to the many out-of-school programmes now available. The Curriculum Development Centre, Ministry of Education, is mounting more in-service training programmes and a recent session held at the Field Study Centre for key personnel reflects the current trend. It is thus hoped that the efforts of teachers toward greater use of out-of-school science opportunities will continue to improve.

Overall evaluative appraisal

As is indicated above, the scope of out-of-school science extends from its links with the formal instructional programme as a compulsory activity to very informal activities for selected groups of students. Accordingly the evaluation of out-of-school science can be seen to comprise firstly, the assessment of learnings through formal avenues. This includes some form of continuous assessment of the success of the projects as well as tests set by teachers. At a more formal level, centralised assessment examinations also contain items to assess students' knowledge and skills in out-of-school science.

Secondly, appraisal of out-of-school science occurs on an informal basis. Activities of Science Societies and teachers are often organized with certain objectives in mind and the achievement of these objectives constitute one major means of overall assessment. Hence, the success of activities or projects can be measured in terms of whether the students are able to carry out the activities, whether they obtain the expected results or whether they have commitment in the work. Of equal importance, is the development of good attitudes toward out-of-school science which can only be done through involvement in its activities. The willingness to participate and the attendance rate in out-of-school activities provide a useful index about the interests of the students.

The Ministry is aware of the need to evaluate the development of out-of-school science and, in this respect has attempted to establish some informal means of evaluation which are not threatening to the teachers, the Societies or the teaching system. The National Science Exhibition mentioned earlier is one way it obtains feedback about the quality of out-of-school science work and the level of participation in such activities by schools. Monitoring of Society activities is also done through annual reports submitted to heads of schools, publications of the society and participation in national, state and community programmes. Unfortunately statistics on the use of opportunities offered by out-of-school agencies are not readily available. However, it has been reported that these programmes are frequently used by Science Society groups and teachers in support of science learned in schools.

Future development potential

In view of the plans to reorientate science education as part of general education for

all in the secondary schools and to infuse issue studies into the existing science curricula as alluded to earlier in the paper, out-of-school activity will inevitably assume a very important place in the school science programme. The new feeling is that there should be better integration and co-ordination of in-school and out-of-school science programmes and that the co-curricular science activities be formalised and used to support the study of social and scientific issues of science curricula. Part of the rationale is that the time available after school can be profitably used by all students and teachers for the organization of projects to carry out investigations outside the confines of the school. The Science Societies which now exist in almost all schools could provide the foci for the development of the idea of an after-school programme of science activities.

More specific to the present practices of out-of-school science activities, much can be done to improve them. The immediate needs seem to be in the area of teacher training so as to make teachers more competent and confident to plan and implement out-of-school science activities. The following are some suggestions made by some teachers of science.

(1) Regular in-service courses on environment-based activities to develop teachers' knowledge and skills in investigations outside the school.

(2) Suggestions on project topics and areas to be explored as well as the practical procedures for investigations.

(3) Means of communication among teachers for sharing of ideas and problems in organizing out-of-school activities.

(4) Information about out-of-school opportunities especially those which are not under the provision of the Ministry of Education.

(5) Financial and consultancy support for out-of-school work.

(6) Activities – refresher courses, seminars, talks, film shows and so on – for teachers at Resource Centres to extend their experience.

(7) Better loan facilities for books and equipment for out-of-school activities.

In summary, it can be said that out-of-school science activities in Malaysian schools are adequate in meeting their purposes as a co-curricular activity. However, if the contributions of such activities to science education are to be increased and to be more closely integrated into the mainstream of the curriculum, then much needs to be done to develop the system in general and the teacher in particular.

10. FIELD TRIPS AND SCHOOL CAMPS — DEVELOPMENTS IN BRITISH COLUMBIA

Fred A. Gornall
Department of Mathematics & Science Education
Faculty of Education
University of British Columbia
2125 Main Mall
Vancouver, B.C. V6T 1Z5
Canada

Canada has far too vast an area to cover in the short space that I have been allotted for this article. I shall therefore refer to approximately 10 percent of it, the western ten percent, that is the province of British Columbia. British Columbia (B.C.) has an area of 984,000 square kilometres as taken from the flat surface of a map but B.C. is a land of mountains and if the true area of all the mountain slopes was measured the actual area would show a bonus of about 20 percent. B.C. is a maritime province and its many fiords produce a shore line of some 7200 kilometres. Approximately 2.4 million people populate this province but 90 percent of them live crowded in the southwest corner. Thus the population density of this corner is about that of Singapore but for the northern half of the province the density of population is about .03 person per sq. km. This would imply two incentives for trips away from the school; to explore the vast open spaces and to escape to areas of fewer inhabitants.

Nor is it practicable to describe the school systems of Canada as each province has its own autonomous system, therefore my comments about out-of-classroom activities will apply only to British Columbia. In B.C. the Ministry of Education and the 75 local school districts give overwhelming support (but not always financial) to programmes of out-of classroom education.

Field trips

Field trips may be considered as single day trips away from the classroom or extended trips which involve at least one overnight and therefore necessitate the inclusion of planning for food and accommodation.

Day trips may be to a beach, pond, park, alpine meadow, swamp, zoo, aquarium, planetarium, botanic garden, waterfowl refuge or local industry. These trips may come solely under the guidance, supervision and expertise of the classroom teacher or they may constitute a canned or ready-made programme offered by the docents, interpretive officers or education officers employed by the institution that is to be visited.

Extended trips usually involve extended and often expensive travel as well as the consideration of food and lodging. These trips may also be under the sole guidance and organization of the classroom teacher but frequently involve other degrees of expertise. They frequently include visits to environmental centres and school camps.

B.C. teachers are under no obligation nor limitation in the number of trips that they may arrange for their classes. Thus some classes may not have the opportunity for even a single trip whereas others may make several of considerable variety within a school year.

When trips are authorized by a principal or local school board the teachers are fully covered by insurance and legal responsibility laws.

In B.C. many of our out trips centre on winter activities such as skiing, skating, snowshoeing, ice fishing or changes in plant and animal life related to the severe winter climate. Any of these activities may be the main objective of the trip or may be incidental to some other major event or topic of investigation. Extended trips may vary from two days to two weeks. Many teachers take advantage of the weekends on either end of a school week for a nine day trip. The majority of the trips are of five days duration. Distance travelled may vary from a few hundred metres to the plot next to the school yard to several thousand kilometres to visit a series of mining operations or heritage villages. Methods of transportation also vary considerably. Hiking and back-packing, bicycle with equipment transported by truck or van, private autos, mini-buses, chartered buses, school buses with sometimes partial expense being carried by a local school board, chartered boats, ferries, canoes, train and even airplane both private charter and scheduled commercial flights are all utilized. The duration, destination and mode of travel are all the prerogative of the organizing teacher.

Accommodation is in campsites with a variety of degrees of facilities provided, hotels, motels, hostels, billets in private homes with the promise of reciprocal accommodation on an exchange at a later date, and on the floor of school gymnasiums or staff rooms.

Places visited may include: mining operations; concentrator and smelter works; fossil beds; forest operations; sawmills; pulp mills; veneer plant; nurseries; reforestation; heritage villages; alpine meadows; streams; ponds; lakes; rivers; ecological reserves; arctic tundra; marinas; wharves; ship loading and docking; fishing and fisheries operations; fish spawning beds; wildlife and conservation reserves; archeological sites; relics; various manufacturing plants and communities.

The number of trips has increased dramatically over the last decade. About twelve years ago the occasional teacher would take a class or a group on an extended trip away from the classroom. These fortunate classes were usually from the upper primary school or from secondary school. Trips were on weekends or in holiday time, seldom ever involving school time. It has now become commonplace for most children to experience one or more extended trips away from the classroom during scheduled school time each year. The age range has been extended mainly downward and now includes extended trips for six to seven year olds. The number of extended trips has also increased in the secondary schools but usually overlaps into non-instructional time. Most trips are organized for grades five, six and seven – that is ages twelve and thirteen.

School camps

Most common are trips of five days duration to attend a school camp. Four of our seventy-five school districts own and operate their own school camp at an established outdoor environmental centre. These are in operation from Monday to Friday throughout the school year. Transportation to and from the camp and all instructional equipment is provided on site.

A permanent kitchen staff prepares and serves meals. Students are charged directly for these food costs. Teachers must attend an orientation workshop prior to their class use of the site.

Four additional school districts rent facilities, buildings, instructional equipment and staff of private campsites and operate them as district environmental centres.

The Canadian Forestry Association operates five environmental centres across B.C. Individual teachers make their own arrangements for the use of these centres. Pro-

grammes are organized by the centre personnel and the users pay a rental fee for the full use of the facilities, staff, equipment and programme. Other teachers independently utilize a variety of church and other private g[illegible] campsites on an ad hoc basis to provide their classes with a school camp experience. Still others, a brave and hardy few, choose their own site and with the help of their students make it into a campsite as part of the programme.

Suggestions for reorganization

Two types of planning are required for each trip:

1. Logistic planning which involves the technical details necessary to ensure the success of any group outing; and
2. Programme planning to ensure a valuable educational experience.

Many manuals, handbooks and brochures outline procedures for the organization of field trips or school camps. I would like to offer a few suggestions not found in these manuals.

The first type of planning is usually well done but it is on the second type of planning that I would like to comment and offer suggestions for enhancement. It is not where the site is located but what is done at the site, what is done prior to the visit, what is done *en route* to and from the site and what is done as a follow-up that is important.

There are two standard ruts into which most out trip programmes fall.

1. Upon arrival at a centre or camp site, students file into a classroom similar to the one that they had just left at school, to be shown or told about the programme offered by the centre. The main motivation was the visit to the centre. Now this must be suppressed until the education officer or the instructor is ready to move on. Remotivation may be necessary before the trip can continue. On several occasions I have observed a return to their regular classroom following this introduction, as there was no time left for the visit!
2. One of the saddest events to witness at a local zoo, even sadder than animals enclosed in their concrete cells, is that of students with a long list of questions that must be answered. Questions that require at least an encyclopedia if not an entire library. Students spend their time at this chore trying to out guess their teacher, borrowing answers from one another but seldom glancing at the animals. The completion of the assignment is of greater importance than the educational experience.

Let us shift to a more positive approach with a couple of examples.

Example 1. Visit to a zoo

Zoos are frequently used for purely academic lessons, sometimes almost entirely limited to traditional classroom type experiences. This is a tragic waste of resource. The following guidelines and suggestions lead to a more positive approach.

1. Use the site to which you have taken your class, often at considerable effort and expense, to its best advantage. Use your time while at the site efficiently. Do those activities that can best be done on site and leave related activities to be done elsewhere. The "introduction" so often considered as necessary could frequently be entirely omitted or at least given at a different time or place. Perhaps if it is pedagogically sound it could be presented in some manner in which the students become active participants instead of passive recipients.

2. Visit the site ahead of the class trip. Make up your questionnaire or assignment sheet on the spot so you will know if your questions are fair and answerable through observation or perhaps manipulation. Here are some ideas that have stimulated children elsewhere:

   a) Make sketches of animals in action. Use simple line drawings that suggest actions such as walking, sitting, eating, drinking, stretching.

   b) Seek out animals that exhibit alarm, happiness, contentment, boredom, misery or fixation.

   c) Find differences in appearance of two or three individuals of the same species. Could these features be used as "natural" markers in the enclosure? for the zoo? for the species? Examples could include giraffe neck spots, zebra stripes, lion whisker pattern, cheetah face spots, and so on.

   d) Make a collection of hair and fur. Relate to previous owners. Take the collection back to class for microscopic examination and comparison.

   e) Make a collection of abandoned feathers. Match them to species of birds. Match them as to type of feather and part of body. Take them back to the classroom for microscopic comparison. Dip some feathers in crude petroleum. Dip some in solvent in an attempt to clean them.

   f) Attempt to collect foot prints of birds and perhaps some other animals. Entice them to walk through mud and then over heavy paper.

   g) Record sounds of birds or other animals on tape. Play back to same individuals. Play back to other individuals of same species. Play back to other species.

3. If this is to be the first visit of your class to that site then allow them time to explore widely and quickly without specific questions to be answered. Then ask a few general questions, i.e. which animal did you like? Dislike? Assign students to watch one animal for one minute (or perhaps five or ten minutes). Ask questions related to feeding, grooming, behaviour related to captivity or abnormal activity.

4. If a repeat visit is planned then ensure that one or two aspects of the site are examined in detail. Several trips could then be made to the same area without overlap of subject material. Examples could include the following:-

   a) What are the similarities and differences between species of cats?

   b) What are some similarities and differences between species of antelope?

   c) Compare a specific animal with a similar species found in a different part of the world.

   d) Interview zoo personnel on their animal breeding programme, its success or lack of success.

5. Involve your students in the planning of the trip. Take two or three along on your preliminary visit as you plan each trip. Ask them to make up some questions that the other students might answer. Observe and listen to your students for ideas that might involve others.

6. Listen to the messages your class is trying to send to you! "Do we have to go to the zoo again?" or "We went to the zoo last year".

7. Pre-trip planning. Do not tell the class all about what is in the zoo or what they are to see and do. Leave the details for work within the zoo until you arrive. Use the motivation for the trip to reinforce or develop other skills such as map

reading, compass directions, bus routes, relative size of the zoo as compared to parks or schoolgrounds and so on.

8. Follow-up the trip with some of the materials brought back. Use the data collected to be augmented by library studies. Again study the zoo as a unit of work. Some subjects for discussion or further data gathering might include: Is the zoo in the best location for a zoo? Could the land be better used for something else? Are there any political issues involved in its location? or cost of operation? What are the thoughts of nearby neighbours as to noise? traffic? smells?

Example II. **School camps**

These are usually operated on a school schedule where traditional subjects must still be identifiable as mathematics, language arts, spelling, art and so on. – how sad! – The programme involves three phases, an academic phases embracing the subjects mentioned above, recreation phase and the social living phase. The academic phase is usually scheduled from 9.00 am until 3.00 pm recreation from 4.00 until 6.00 pm and social living in the remaining hours.

In a recent survey on the likes and dislikes of students who had participated in school camps, the strongest negative reaction was "standing around waiting for something to happen". A follow-up study showed that this was indeed true. Perhaps there is a relationship between the academic-recreation-social structure which makes time wasting inevitable. Let us turn again to a positive approach. Here are suggestions for more efficient use of both time and the site:

1. Integrate the three phases mentioned previously. Why should every person be doing the same thing at the same time? This makes sense in the use of equipment and space as I have yet to see the centre or classroom that has sufficient equipment to accommodate all students at the same time. Spread "academics" throughout the day and integrate with recreational pursuits also spread throughout the day.

2. Use the evening period, for example, for studies which can seldom if ever be done in most classrooms, astronomy, or just plain star-gazing. Sunset, sunrise and night sounds also fit this pattern. Here also is an excellent opportunity to record weather data not normally observed. The moon of course is much more readily observed at this time.

3. Most camps are inundated with signs which stress the negative. "Do not run", "No swimming", "Do not light fires", No cutting of trees", "Keep off the grass", etc. Let us replace these if they are truly necessary with positive signs. "No running" becomes "Please walk in a quiet respectful manner".

4. Set aside places where the normally forbidden activities may be carried out. "The Use of Axes, Knives and Saws is Allowed only in this Area". Set aside an area where one tree, one stump and one log may be hacked, cut or otherwise mutilated. Similarly an area should be set aside for fire lighting and yet another area where digging or planting may be carried out.

5. Arrange for camp staff to share the load, spell one another off or work in shifts. In most camps all staff work 16 hours each day from Monday to Friday as long as classes are present. This should not be. Shifts of not more than eight hours are sensible and practical. Additional supervision will be necessary. We have found part-time volunteer supervisors readily available. Some sources for these volunteers are older students in special community activity programmes as part of their secondary school courses, parents, pensioners and other citizens, workers on vacation, injured persons under recuperation, trade-offs with other teachers, and on weekends ordinary in-

terested citizens. The supervision ratios recommended by national youth organizations across Canda are: 1-10 for adults, 1-8 for older children and 1-6 for young children.

6. Help out the cook and at the same time give your programme more flexibility. Most camp programmes are organized around the cook's schedule. A compromise can be worked out to reduce the cook's work. Set up a buffet lunch counter where individual or groups of students can come to lunch at their convenience and make their own lunches. We have also effectively organized breakfast on this same scheme. The evening meal is retained as a family gathering. The use of students in the kitchen may be necessary to trim the financial budget but it is an inefficient use of the student's time from the educational aspect.

7. Arrange grouping on strenuous activities so that the more robust students have a greater challenge. This could involve travelling a greater distance to reach a designated destination, or travel a tougher route or simply stagger the times of departure so that the stronger group leaves last and must travel faster to arrive on time.

8. Better preparation of teachers for this type of activity is essential. Instruction in logistical and programme planning must be incorporated into programmes of teacher education. In-service training programmes must be provided to aid those teachers who require or desire additional help and information. In British Columbia we have much help with this from non government sources. The Canadian Forestry Association frequently provides weekend workshops for teachers sometimes with children also involved. Private companies arrange for week-long workshops and visits to forest oprations and mining activities at no charge to the teachers. Teachers are released from class during school time for these sessions. A second forestry organization, the Festival of Forestry, arranges tours of forest operations for combined groups of foestry and education students from the local universities.

9. Evaluation instruments must be developed to show the worth of out-of-classroom experiences. Hambleton, 1977, has used surveys of teachers, principals, parents and student participants in attempts to measure the value of these programmes. Several graduate students have attempted to measure their worth. Bateson, 1981, has demonstrated and documented that there is a change in interpersonal perceptions and reltionships of teachers and students as a result of residential experiences. This type of research must continue. There is much room for research into the nature and degree of personality changes.

I would like to finish off by borrowing a phrase from Hambleton's survey when he asked a student to describe his recent camp experience to another student: "Do what they say and you'll have the best, safest, greatest time of your life".

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11. OUT-OF-SCHOOL ACTIVITIES IN JAPAN FOR PRIMARY AND SECONDARY SCHOOLS

Kozo Imahori
Fukui Prefectural College
97 Ohata-cho
Fukui-shi 910
Japan

Economic development and the popularisation of education in Japan over the past few decades have both occurred together and each has contributed to the growth of the other. As a result of this accelerated development school education in the past has tended to over-emphasize intellectual aspects while moral or social training has been given less emphasis. Recent cases of violence in families and schools provide examples of the vicious influence of the older biased approach to education in our schools. It has become increasingly obvious that out-of-school activities have a critical role to play. Of such activities, science activities are especially well developed in Japan. Above all, national and public children's nature study centres are proving to be particularly effective. However, we have to solve several problems involving sites for out-of-school work; teacher education and attitudes of pupils in order to promote out-of-school science activities more extensively.

Education and development in Japan

During the past decades our national economy has developed remarkably and the Gross National Product (GNP) has dramatically increased. It is generally accepted that this development was possible, partly at least, by the impact of our popularization of school education, the growth of which is shown in Figure 1. Nowadays almost 99% of children attend compulsory 1st to 9th grade classes, a fact which explains that all Japanese can read and write not only Japanese but also English. Their average attainment in mathematics and natural science is extremely high as measured on international standardized educational achievement tests, as shown in Table 1.

It seems, however, that *out-of-school* education did not contribute a great deal to economic development. This was because organizations such as libraries, science museums, field centres and so on, had not been planned properly to grow in pace with economic developments. It must be also accepted that popularization of education, especially at higher levels, introduced into our country what in popular parlance has come to be called "entrance examination hell". As a result school education has tended to remain academically biased, and certain troubles such as the emergence of school 'gangsters' have become evident. The Ministry of Education, Science and Culture the Government of Japan recently took strong countermeasures to meet this disastrous situation. The present article describes some of these countermeasures and adds my own opinions and ideas in relation to the role of out-of-school science activities.

Changing aspirations of Japanese children

The behaviour values of children are intimately related to trends such as urbanization; the development of an information-based society; tendencies towards smaller family; and popularization of higher education, all of which have emerged because of our high rate

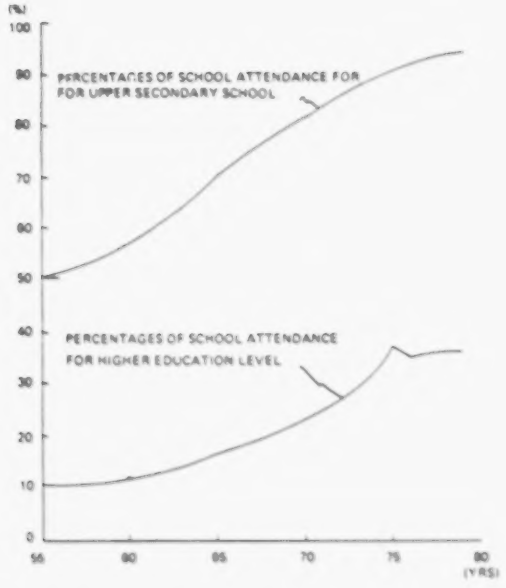

Fig. 1: Popularization of education in Japan.

of economic development. Diversified and changing views of the worth and role of family, society and nation have also arisen. This rapid transition and diversification has kept pace with the high degree of economic development and has strongly influenced the character building of children.

Economic development and increase in the GNP has brought a levelling of income and a large part of the nation has come to sense that they belong to the middle class of society. This has brought definite benefits as our children now grow up in comfortable and peaceful circumstances. Their physical well-being has improved and their favourable

Table 1

Average scores of the educational achievement in science (1969) in several countries on standardized tests

10 yrs. old	(full score 40)	14 yrs. old	(full score 80)
countries	Av. scores	countries	Av. scores
Japan	21.7	Japan	31.2
Sweden	18.3	Hungary	29.1
Belgium	17.9	Australia	24.6
U.S.A.	17.7	New Zealand	24.2
Finland	17.5	W. Germany	23.7
Italy	17.5		

circumstances have provided opportunities to enjoy sports, arts and other forms of entertainment as part of out-of-school education.

On the other hand, urbanization has introduced a decline in feelings of solidarity, social co-operation and awareness of public responsibility. Many young families have moved from rural to urban life, where they have had to defy many of the traditions of their parents' society. Open spaces and farmlands, where once many children of different ages joined together and learned about co-operative solidarity and the need for rules and regulations are now rarely found in cities. Places which once bestowed the favours of nature are hardly found in urban life and children have lost the chance to learn about the natural world and to develop a sense of respect for nature. All these situations have disturbed the sound development of mind and body. An understanding of human kinds place in nature is the most significant reason why out-of-school activities must now be promoted very strongly in Japan.

It can be properly said that the popularization of school education has influenced out-of-school activities. The percentage of pupils who go on to the upper secondary school has increased from 60% to 94% during the past twenty years. Similarly the percentage who went on to higher education in 1960 was only about 10%. In 1980 this increased to about 40%. Accordingly many youngsters of today have been brought up on a 'bed of roses', separated from the storms of day-to-day life in the real world. Social education therefore is now seen as an important role for out-of-school activities and it needs to be given more emphasis keeping pace with the increasing popularization of school education.

Curriculum reform

In recent years so-called "blackboard jungles" or outbreaks of violence in family or school are becoming alarmingly widespread in our country. The violence occurs most frequently in the lower secondary schools, and some schools have to hold their commencement ceremonies protected by police (see Table 2).

Table 2

Incidence of Violence in Japanese Schools 1976 – 1980

Year	Lower Secondary School			Upper Secondary School		
	Number of Cases	Number of Rioters	Number of Victims	Number of Cases	Number of Rioters	Number of Victims
1976	1,575	4,053	2,526	726	2,168	1,076
1977	1,294	4,358	2,546	579	1,985	1,102
1978	853	4,288	1,859	439	2,475	1,023
1979	892	5,141	2,296	316	1,578	878
1980	1,202	7,108	3,837	336	1,950	990

The tendency towards juvenile violence is also obvious in developed countries such as the United States and West Germany, but it is rather difficult to clarify why violence occurs so frequently in those countries. However, so far as Japan is concerned, it seems that outbreaks of violence relate to the popularization of education, at least in some parts of the country. Violent pupils are usually poor attainers lacking ambition or enthusiasm for study. On the other hand, many pupils have to study hard even after returning home each day after school, in order to keep at an average level in their class, otherwise they might fail their entrance examination – they become victims of the "entrance examination hell" to which I previously referred. The tendency towards violence has been noted with concern by the educated public, and the Ministry of Education has responded by reforming courses of study from 1981 and "allowance for latitude in fruitful school life" is now the catchphrase (see Table 3).

Table 3

Class Hours for Each Subject of the Lower Secondary School, Revised from 1981.

( ) Shows Class Hours Before 1980

Subjects	7th Grade	8th Grade	9th Grade
Mother Language	175 (175)	140 (175)	140 (175)
Sociology	140 (140)	140 (140)	105 (175)
Mathematics	105 (140)	145 (140)	140 (140)
Science	105 (140)	105 (140)	140 (140)
Fine Arts	70 (70)	70 (70)	35 (35)
Music	70 (70)	70 (70)	35 (35)
Physical Education	105 (125)	105 (125)	105 (125)
Technology & Household	70 (105)	70 (105)	105 (105)
Morals	35 (35)	35 (35)	35 (35)
Foreign Languages	105 (140)	105 (140)	140 (140)
Special Activity	70 (50)	70 (50)	70 (50)
TOTAL	1,050 (1,190)	1,050 (1,190)	1,050 (1,155)

Total formal class hours for the lower secondary school have been reduced from 3,535 to 3,150 through 7th to 9th grade. Moreover, the subject "special activity" which includes out-of-school experiences such as excursions, sports and visits to museums and so on has increased from 150 to 210 hours per academic year. This emphasis on "allowance for latitude in fruitful school life" and the promotion of out-of-school education came together in a recent speech (January, 26 1981) by Prime Minister Suzuki, who spoke as follows:

"The hoped-for prosperous society cannot be realized only by materialism. Spiritual replenishment and esteeming human nature are more important. In order to expect

our youth to support our society in the next century, we have to train their individuality and creativity through science education in school, home and in society. They have to be proud of our splendid culture and tradition, and to have a broad view of things and of the world spirit.

The basis of education can be found in the affection that exists between parents and children as well as between teachers and pupils. Violence that occurs in families or schools is very deplorable and I am convinced that strict discipline sustained by deep affection and awareness of responsibilities must be attained in our nation's society in order to accomplish sound education."

Recent sociological research

Violence occurs only in about one per cent of the population of any one age group. However, the occurrence of violence is more or less related to the general social inclination of young people, a summary of which is shown in Figure 2. A recent questionnaire study of 5th to 9th grade pupils in Japan revealed some interesting answers in response to the question "How would you like to live in the future?". It was shown that self-centred types who could be grouped into responding categories such as "life to their liking", "enjoy happy married life" and "enjoy optimistic daily life", consisted of almost 50% of the pupils, whereas public-centred types who would say things such as "work for the public benefit" or "to live cleanly and fairly" consisted of only about 32%. Ambitious types such as those "wishing to be a millionaire" or "to be a celebrated person" formed only about 12%. This tendency is also found to a degree in adults and has become more marked during the past two decades as shown in Figure 3.

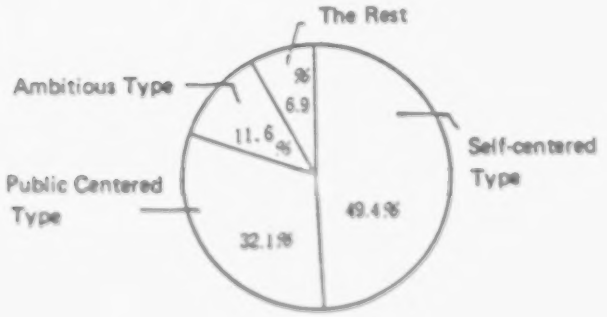

Fig. 2: Inclination towards particular life styles among young people in Japan.

It is a lamentable fact that the tendency is becoming ever more marked. It demonstrates that many adults are unwilling to accept social responsibilities.

This evidence therefore adds to the argument that in Japan economic development has brought material property but also some unfortunate results in unadaptability to social life in general. Promotion of out-of-school activities therefore is seen to be of vital importance.

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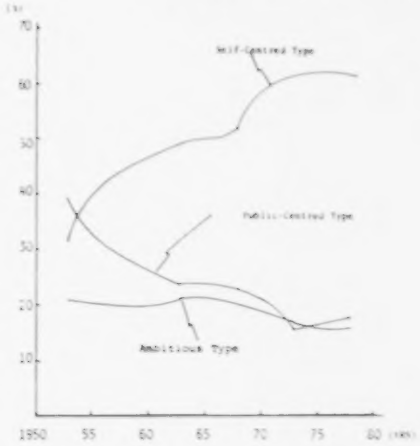

Fig. 3: Changes in life style preferences of Japanese adults 1950 to 1980.

Promotion of out-of-school activities

Promotion of out-of-school education has a most important role in the formation of human nature, that is, in development of a balanced personality. There are many forms of out-of-school activities but in this article I will discuss only science and social education including physical education and sports – see Figure 4.

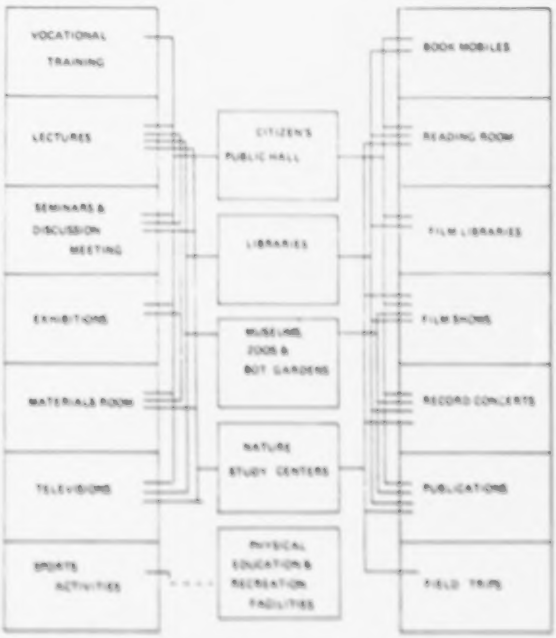

Fig. 4: Social education facilities and their activities in Japan.

1. **Museums – especially in the sciences**

As shown in Table 4, the number of museums has steadily increased during the past decade, although the growth rate for science museums has been lower than for history or fine arts. The number of pupils visiting science museums, however, is markedly greater than for the others. (Table 5). Accordingly science museums significantly contribute to out-of-school education. Although the Ministry of Education advises "that science education should be through the direct experience of nature", it is rather difficult to fully implement this policy since our land has been extensively exploited. There are very few wild natural areas near cities. Visiting science museums can be an effective substitute for teaching through nature itself. In some cases museums *can* be used for a direct experience of nature and at times are the *best* resources for certain topics. For example, the teaching of evolution and phylogeny can be most effectively undertaken in museums by using many groups of displayed organisms, both existing and extinct – something not feasible in the natural environment.

Table 4

Number of Museums in Japan – 1968 to 1978

Years	1968	1975	1978
Science Museum	43	52	59
History Museum	83	113	136
Fine Arts Museum	77	101	135
Nature Study Centre	4	3	5
Zoo	22	28	29
Botanical Garden	18	19	18
Nature Garden	5	6	9
Aquarium	31	25	27
General Museum	55	62	75
TOTAL	338	409	493

Table 5

Average Number of Visitors to Each Type of Museum (1977)

Facility	Total Visitors	Pupils Visited
Science Museum	183,000	70,000
History Museum	102,000	25,000
Fine Arts Museum	84,000	8,000
Nature Study Centre	339,000	111,000
Zoo	1,056,000	460,000
Botanical Garden	232,000	63,000
Nature Garden	1,269,000	370,000
Aquarium	376,000	111,000
General Museum	203,000	65,000

2. Children's nature study centres

The idea of youth centres was first raised in 1972 as a national utility enterprise of the centenary anniversary of the education system in Japan. The first centre was opened in January 1975 at Muroto. Since then five centres have been founded and another five are now under construction (1981) (Figure 5).

Fig. 5: Location of National Children's Nature Study Centres, constructed and programmed (1981).

Each centre is a unique and valuable facility for pupils of elementary and lower secondary school level. The educational aim is to make youth familiar with nature, to develop their social skills and to extend their physical and mental activities through residential training in natural areas. The main activities of these centres are as follows:

a) *Inquiry into nature – love of nature*

Adventure in nature, including fishing and hiking. These activities include special lectures and simple field assignments. Nature study leaflets and guide books are always available and Teachers' Guides are occasionally provided.

b) *Training in social co-operation in nature through field work*

Camping, including cooking and campfire, cycling, hiking and similar activities are involved in this part of the programme.

c) *Productive activities*

Cultivation of plants, breeding of small animals such as rabbits, chickens and ducks, and "green" adventures are programmed. Handicrafts and painting are also included here.

The numbers participating in these national activities is growing steadily as shown in Table 6, although only 0.05% of any one age group had participated during 1978. The number, however, show that the centres are used extensively. One reason for the popularity of the centres is that children are freed from their school classes for about 100 days a year, including vacations and weekends. The centres are fully utilized for about 90 of these 100 days. In addition there is a network of over 130 *Children's Nature Study Centres* available to the general public – see Table 7. About 1,500,000 children including 525,000 overnight residents were registrated in 1978.

Table 6

Number of Pupils Visiting the National Children's Nature Centres – 1976 to 1978

Year	1976	1977	1978
Number of Facilities	1	3	3
Each Capacity	400	1,000	1,000
Number of Visitors	28,704	93,005	235,624
Number of Overnight Visitors	17,071	56,936	146,372

Table 7

Visitors to Public Children's Nature Centres in 1978

Number of Facilities	Number of Visitors				
	Overnight	2 Nights	3 Nights	4 or More	Total
136	851,239	540,034	43,457	3,708	1,438,438

3. **Visits to natural history institutions and field work**

Visits to zoos, botanical gardens and aquaria also have an important role in out-of-school activities. These types of institutions usually prepare several kinds of guide books and work books for school teachers and pupils. Guide books include taxonomical and ecological explanations. Monthly leaflets containing quizzes are also prepared by museums and these are highly valued by teachers and parents. The contributions and popularity of these institutions is shown numerically by the large numbers of children who visit them compared with the numbers of adult visitors.

Children's nature education centres, as already pointed out above, also contribute to field work, as shown in Table 8. These data were obtained from a recent questionnaire survey undertaken by the National Museum for Nature Education. These centres, however, are handicapped by a shortage of adequately trained field work instructors and managers (see Table 9).

Table 8

Question : "Did you conduct field work?"

Facilities	No	Yes	Others	Total
Museum	17	53	2	72
Education Centre	1	12	0	13
Nature Study Centre	16	51	1	68
National Park	15	16	0	31
Public Bodies	7	28	0	35
Private Bodies	10	119	2	131

Table 9

Barriers to Field Work

	Educator	Business	Method	Others	Total
Museum	3	6	0	0	9
Education Centre	1	0	0	0	1
Nature Study Centre	7	1	2	5	15
National Park	4	7	0	5	16
Public Bodies	0	2	1	3	6
Private Bodies	1	2	1	3	7

Accordingly museums, private groups (such as voluntary associations) and scientific societies which can provide competent instructors are most active in field work – see Table 10. This point is made more evident by the data from the same survey shown in Table 11. Another problem for the public Nature Study Centres is that adults, especially older people, enjoy and are willing to attend field work in general, whereas few children or youngsters join in these activities voluntarily.

Table 10

Frequencies of Field Work Activities Per Year

	1 – 5	6 – 10	11 – 15	16 – 20	21 – 25	26 – 30	31 or more
Museum	39	4	4	2	2	1	2
Education Centre	6	4	1	0	0	0	0
Nature Study Centre	30	6	2	1	0	0	6
National Park	7	3	1	0	0	0	1
Public Bodies	20	1	2	0	0	1	1
Private Bodies	60	28	14	4	2	0	1
Total	152	46	24	7	4	2	11

Table 11

Number of Educators for Each Facility (%)

Educators	1	2	3	4	5
Museum	18	29	18	18	18
Education Centre	9	18	27	27	18
Nature Study Centre	28	31	28	6	6
National Park	29	21	29	14	7
Public Bodies	0	20	40	20	20
Private Bodies	10	8	27	29	25
Average	17	20	27	20	17

Problems of out-of-school science activities in Japan

It is generally accepted that out-of-school science activities have a very important role in fostering a balanced personality, especially to modify or complement the present over-emphasized intellectual training given at school. Many organizations and facilities are making every effort to promote out-of-school activities and these programmes are demonstrably effective. However, generally speaking, the present situation is far from satisfactory. Problems are found on both sides – relating to pupils and relating to the educating bodies.

Problems relating to pupils: As already pointed out the popularization of Higher Education has brought about the so-called "entrance examination hell" in Japan. In order to find a good job, children want to enter a famous university such as the University of

Tokyo and parents encourage this ambition. In order to be students of a famous university they have to enter Upper Secondary school with high qualifications. Since entrance examinations for Upper Secondary school stress a great deal of memory work, pupils have to study very hard and even have to cut down on their sleeping time. "Four hours pass but five hours drop" is an idiom among pupils preparing for the entrance examinations. As a result these pupils have no time to join out-of-school science activities. According to other recent questionnaires surveys, many out-of-school organizations *except* Children's Nature Study Centres pointed out that very few secondary pupils attended and even those who did attend were generally inactive and less interested in nature. My own generation grew up surrounded by nature, but our youngsters are living in an artificial world and as a result many are unfamiliar with and ignorant about nature. The world of nature is unknown to them and they are afraid to explore this unknown.

Problems relating to educational bodies: The most serious problem is that the number of teachers who have a good knowledge of nature, especially of the names of plants and animals and their ecology, is very small. After World War II, our universities developed and expanded in specialized fields of natural science and technology but neglected the classic areas of biology. During the past 35 years biology has developed a high degree of differentiation, especially on the molecular level. Many universities established new departments and chairs related to molecular biology, biochemistry and biophysics, at the expense of taxonomy and morphology. As the result, the curriculum of biology had to be modified to match the new academic specialities of the teaching staff. Nowadays, it is not strange to find professors or students of biology who can scarcely identify any of the more common plants and animals. It happens, therefore, that school science teachers hesitate to conduct field work since they cannot answer pupils' questions about nature. It is obvious that many educational bodies offering out-of-school activities need staff who can guide children in natural history and ecology.

The second problem to be emphasised is the location and quality of natural areas suitable for out-of-school science activities. Economic development has been accompanied by the extensive destruction of natural areas. Even whole mountains have been levelled in order to construct factories and houses. Many highways have been constructed through hills and forests. Farmers and their families have moved away from their rural homes to urban areas. It is virtually impossible now to find primaeval forest in Japan. Wild places close to transport are virtually non-existant.

Conservation is the third problem. There is a paradox. It is true that while out-of-school education in natural areas contributes to an understanding of conservation, Nature Study Centres, by their very existence, are destined to destory wilderness areas. Since collecting animals and plants for study is contrary to the very idea of conservation, the problem is to find a compromise solution between the demands of nature study and the need for conservation.

Conclusion

It has been shown that economic growth and popularization of education in Japan have accelerated correspondingly during the past few decades. As a result of the acceleration, school education has over-emphasized academic intellectual objectives at the expense of moral and social training. Violence in families and schools can be explained in part by the influence of this biased education. As a counter-measure, out-of-school science activities have been encouraged. Among these, the activities organized by Children's Nature Study Centres developed during the last decade are now producing fruitful results. We, however, have to solve several problems relating to attitudes of pupils, shortage of teachers and qualities of availability of wild areas, in order to promote out-of-school science more extensively.

12. OUT-OF-SCHOOL SCIENCE ACTIVITIES — RETROSPECT AND PROSPECT IN THE CARIBBEAN

Winston K. King
Department of Education
University of the West Indies
P O Box 64
Bridgetown
Barbados

It is important from the very outset to give as clear an indication as possible as to what is meant by Out-of-School Science Activities.

A perusal of the literature indicates that there are two main sets of ideas which may be different but are sometimes quite similar. On the one hand there is the idea of out-of-school science activities being those which, although structured, lack the rigour usually associated with formal classroom activities. These activities may be used as extensions of classroom instruction or mainly as enrichment. Under this heading would fall such things as homework and science projects. The other idea is to use the term, outdoors, synonymously with out-of-school, and to imply that the main focus of such activities is for developing an awareness of and love for the environment.

In this paper I propose to use both ideas as they relate to the Caribbean situation. The intention in the paper is: to look at a rationale for out-of-school science towards the development of an undergirding philosophy; to formulate a set of aims; to examine the implications of out-of-school science for educational systems in the Caribbean and to highlight some of the many activities which we pursue from time to time. Some attempt will be made to evaluate the various activities in the light of the impact they make on the countries in the region.

Rationale for out-of-school science activities

Professor Bain (1980) in examining the virtues of using the outdoors gives three categories of reasons: reality, communication and social interaction. In the Caribbean region I see some other reasons coming into focus besides these three: for example, economic, educational, attitudinal and recreational. Reality, communication, social interaction and economic development are, however, central to any thinking in this area.

Reality. Out-of-school activities could give reality to various classroom activities, providing possibilities for collecting data, or for illustrating theories and principles. This 'anchoring' of theories in reality is a most important rationale for out-of-school science. Bain argues that certain studies like the communal life of the honey bee, or observing the heavens in astronomy can only be done in the outdoors.

Communication. On the point of communication, Bain expresses the hope that the feeling of freedom engendered by the outdoors should go a long way towards 'greater communication and understanding of other people'. This communication need not necessarily be between the school and society. The time has come, I believe, for school

science to play a more intimate role in the community. There is evidence of *ad hoc* interaction between the two but the language of the communication seems somewhat in dissonance – the two parties are not understanding each other.

Social interaction. Social interaction, which is closely related to communication, is facilitated immensely by outdoor activities. Bain insists that people develop better attitudes to one another particularly in co-operation. I see this point as being very essential and I will return to it later.

Economic development. In the Caribbean region at the present time many out-of-school science activities are geared towards raising the level of consciousness in areas such as agriculture and farming. The feeling is that heightened levels of consciousness will help to break down barriers of aversion to craft and other exploits of a relatively non-academic nature. This in the end would lead to increased production at all levels, and a healthier economy. Some educators, however, disagree entirely with the rationale that education should be built on the economy and such matters. They see education as being more geared towards personal development and fulfilment. A full consideration of arguments for and against this position should not concern us too much in this article. However, it should be noted that a policy of education for manpower needs is a general one and is not confined to science education.

Figueroa (1971) summarizes this whole question in this way:

> 'That schools and school systems should make a contribution to economic development through the kind of pupils they offer society, is clearly to be admitted. That the school should aim to be concerned about economic development and to ensure that it does everything to encourage its pupils to have a care for the whole development of their society and of all mankind, is not to be denied. But that the school can make a significant, direct, and large contribution to economic development, is much to be doubted. . .
>
> Any kind of education which aims mainly at turning out a certain kind and size of labour force, is not education at all. Moreover, it is likely to be inefficient even in the limited aim of turning out a certain kind of manpower because man is more than a cog in a vast industrial wheel. To educate for manpower needs and not for manhood is bound to end in frustration and perhaps bloodshed, for it raises people's expectation for dignity as well as bread, and, in the end, it gives them stone.'

Education for scientific literacy

I believe that out-of-school science activities have a powerful role to play in developing scientifically literate citizens. This development is not confined to learners in the formal setting but also encompasses people in the larger community, on whom such activities impinge. There is a sense in which when persons speak of education they mean that which is carried on within a prescribed place, and which includes all the trappings associated with 'school'. Why else would policy makers feel that every possible subject area could only be imparted as part of the school curriculum? There is a need for non-formal and informal methods of education to reach all sectors of the community. In conversations with Principals throughout the Caribbean region I am struck by the disquiet that they feel about the overload in the school curriculum. Besides the 'core' areas, such subjects as tourism, co-operatives, drama and others are gradually creeping in. Surely it must be understood that although schools are potent forces in education, they cannot be the sole force. Furthermore, such a multiplicity of subject areas demands a different approach to teacher training in an effort to produce a new breed of teachers. Only too often the subject is introduced into schools without the necessary attendant changes in preparation of teachers.

This is why the idea of using out-of-school activities to educate in science should be given urgent consideration. There needs to be, of course, careful planning of objectives, methods and content that are in keeping with the needs and aspirations of all concerned. What we must strive hard to prevent is the presentation of science as anecdotal and magical. If well organized and used, such activities could go a long way towards producing citizens with levels of knowledge and awareness in science, to be able to lead a 'full life' in this scientifically and technologically oriented world.

Awuku (1978) argues that because the use of the scientific method of enquiry is so important in effective learning, every attempt must be made to involve our students in science projects and science fairs. On the question of the value of science projects he writes: "The project approach has unique application in the teaching-learning process. It provides a student an opportunity to undertake investigations for the solution of problems. Also, the student has a chance to be creative. . . Each student has a chance to 'achieve' according to his ability and interest." He sees science fairs as 'follow-up' to science projects: "Successful science projects may lead to science fairs, and not *vice versa*. In other words, where science projects have been recognized as important aspects of science instructional programmes, it is usual to organize science fairs so that such projects can be exhibited to both participants and the general public."

There seems to be a very strong case for using out-of-school science activities, not only for education *per se*, but for alleviating some of the disorders of underdevelopment such as lack of technological expertise, and the great reluctance to change.

Changing attitudes

This educational reason for out-of-school science activities leads naturally into considerations of changing attitudes. Knowledge may not by itself change attitudes but the hope is that where beliefs are misguided by ignorance, knowledge might help to shed new light.

Various Caribbean writers have from time to time deplored the lack of a proper scientific attitude in the region. This lack is usually manifested by the alacrity with which some people ascribe unusual phenomena to divine or magical powers. There is the lack of a spirit of enquiry or inclination to 'find out'. Figueroa (1971) in what is considered as one of the most serious criticisms of the absence of a 'scientific spirit' says this:

> "Society in the West Indies is mixed or plural – depending on what view one takes and on what territory one has in mind – not only on the grounds of language, social structure and general values, but also in the whole approach to 'causal' explanation of natural and human phenomena. Some seem to believe in an almost entirely chance-magical explanation of events; others tend towards the more so-called scientific explanations and understandings. . . One can hardly be held responsible for actions over which one has absolutely no control or which are explicable entirely on grounds of chance. One does not have to be either a complete rationalist, or an out-and-out utilitarian, to realize that developed industrial society must rest on some notion of cause or at least invariable correlation. It is difficult to see how West Indian Society can develop without more of an injection of the scientific spirit and temper."

But change of the attitudes towards science, scientific and technological advances is not the only way in which out-of-school activities could make an impact on attitudes. These activities could also make an impact on how the wider community views the environment. Is the environment somewhere to be exploited at all cost, in the name of progress? Or is it something to be cherished and carefully marshalled for its non-replaceable resources? Therein lies the crux of the matter. As one of our calypsonians in a well-known social commentary puts it: "The price of progress is high". Out-of-school activities

help to foster desirable attitudes towards the environment and cultivate the awareness of the pivotal role of man in conserving our resources for the future generations.

Recreation

The environment should not be seen solely as a source of wealth, and hence economic development. The environment should be used for healthy recreational activities. These latter become more and more important as people get more and more leisure time. The test of development lies in the judicious use of leisure and recreational time. Here again I see out-of-school science activities being useful in stimulating people to use their environment for recreation. See for example the article by Professor Rao on the *Biology of Leisure*. (Ed.).

Aims of out-of-school science

From the foregoing attempt to build a rationale for out-of-school science by looking at their various uses, it behoves us to formulate some aims of such activities. By so doing one would then be in a position to analyse the various activities in the light of which aim that is being pursued, and to what extent there is success or failure.

In the Caribbean region I see the following statements as capturing the essence of what out-of-school science should aim to achieve:

1. To ease the pressure on the school curriculum.
2. To help to focus on the community and environment.
3. To help to cultivate desirable attitudes towards science.
4. To help in the general education of the community.
5. To encourage the use of scientific method to search for problems.
6. To foster scientific literacy.
7. To provide some answers to community and environmental problems.
8. To help to eradicate the myth that education is within school walls only – towards non-institution-based education.
9. To produce a heightened awareness of importance of the environment for development and recreation.
10. To help remove the stigma attached to manual work and work of a non-academic type.
11. To help eliminate the belief that strange phenomena are magical and to stamp out superstition.

Implications of out-of-school science for educational systems in the Caribbean

The aims of out-of-school science formulated above have several urgent implications. These are discussed below.

Finance. Perhaps the most important implication of these activities would be in the area of finance. This is not strange in a region where there is a lack of natural resources. Money is needed to build the infrastructure within which such activities could be planned and implemented. From my experience in the region, I am fairly sure that the question of finance will come quite early in any discussion in which an educator is attempting to interest a policy-maker in putting more emphasis on out-of-school science activities. I feel that decision-makers should look more at cost in relation to benefit to be derived. If such an analysis is done then it seems pretty sure that these new activities would prove highly beneficial both in tangible and intangible aspects.

Examinations. The Caribbean region is one which is greatly oriented towards examinations. It is true to say that there are certain examination hurdles in our lives, which if we do not negotiate successfully, may have an immense effect on the remainder of our lives. It would therefore, be very difficult to convince people that activities which do not culminate in strict examination grades and hence certificates, is worthwhile. This is the position to which I alluded earlier in this article when I saw one of the aims of out-of-school science as leading to the development of non-formal and informal science education. Some ways and means must be found to assess attainment in the proposed activities lest society view them as soft and 'wishy wash'. In a sense, insistence on acceptable procedures may defeat the purposes for which the activities were conceived in the first place. The resolution of this delicate matter is necessary if out-of-school science activities are going to get favourable conditions under which they could become established and flourish.

Curriculum. Science curriculum in schools will need to change if only in philosophy, to accommodate the new approaches. If out-of-school activities are going to realize their full potential then they must be conceived as providing fairly structured conditions for acquisition of knowledge, skills and attitudes. They must be seen less as hobbies and 'light' excursions into nature, and more as occasions for demonstrating principles and theories learnt in the classroom, and for the collection of data and information. I do not mean to denigrate the idea of hobbies in anyway but, bearing in mind the many ills which beset school science, I see the proposed approaches as offering new opportunity for developing the teaching/learning situation.

The new approaches also have implications for development of science curricula. Maybe the old classical models of curriculum development would need to be modified to reflect the new stresses on the community and the environment. Maybe the questions to be asked before one ventures into such developments need to be changed to focus on new concerns and solve new problems.

Teacher training. Closely related to consideration of curriculum planning and implementation in out-of-school science activities is the consideration of teacher training. There can be no meaningful change without a re-thinking of the ways in which we train teachers to handle such change.

Out-of-school science activities force teachers to relinquish the role of knowledge source, and to assume roles of facilitation, manager and guide. Out-of-school science activities by their very nature are liable to produce answers that are not 'right' or 'wrong' in the traditional way we use these words. Take science projects. The important consideration is not necessarily product but rather processes and skills. This has implications for objectives, content, methodology and evaluation in teacher training.

Teacher training for these new approaches would of necessity also include some aspects of human relations and human psychology, since it is expected that teachers (and pupils) are likely to be more in the 'public eye'. Related to this aspect of human relations would be the need to understand how adults learn, and hence in what form should science materials be presented to have maximum benefit.

I see the need for new directions in teacher training to meet these new demands as being one of the main factors deciding the success or failure of out-of-school activities. Without this change in direction any efforts are likely to founder.

Change in philosophy as to what is most worthwhile. Somewhere along the line, if decision-makers accept the argument of rationale presented in this paper, it will become necessary to re-examine the whole philosophy of science education. This re-examination is necessary because the new approaches pre-suppose certain assumptions. For example, the new approaches move the centre of action and concern away from classrooms and

laboratories into the wider area of the community and environment. It requires therefore a new conceptualization of what is worthwhile, and hence, what we intend to pass on of the culture. Maybe science education for community development would take on new meaning as the boundaries between school and community become progressively blurred.

Such change in philosophy does not come quickly. Besides it must be examined and re-examined in the light of future change in the needs, and aspirations of the people. Communication between decision-makers and the community is a necessary ingredient of any planned change.

Some out-of-school science activities in the Caribbean

There are at present at least four categories of out-of-school activity in the Caribbean region. These are briefly described below.

Activities emphasizing applied sciences. The bulk of the out-of-school science activities in the Caribbean are related to aspects of applied science, for example, agriculture and farming. In most countries there are 4H clubs which train youth in techniques of agriculture, including poultry, sheep and pig rearing. This concept of a club had its origin in the United States but has been transferred, with varying degrees of success, into the Caribbean situation. Here the instruction is of a practical nature and is geared towards improving knowledge, skills and attitudes in the areas mentioned above.

Of similar style, but less frequently encountered are the various co-operatives. In this respect Guyana could be considered the country in which co-operatives seem to flourish best. These co-operatives, apart from featuring skills, also cater for group selling and buying in an effort to cut cost. The knowledge and skills, as well as the money, of all the members are shared, and in theory disbursed according to each member's capacity.

Guyana also boasts of its National Youth Service, which while seemingly military, has a great input of agriculture. The thrust seems to be towards developing certain skills and attitudes so necessary for the development of that country's vast hinterland. The National Youth Service has as its counterpart the National Service which emphasizes the development of leadership qualities.

Belize runs residential youth camps which also place some emphasis on the application of science to environmental problems. There seems to be in this country a thrust towards 'rural education' in an effort to bring seemingly remote areas to full realization of their role in the country's development.

In some countries there are clubs or groups which have as their focus appropriate technology. These are of recent vintage and have been formed mainly since the world energy crisis. Their task then is to search for, among other things, alternative sources of energy and to spearhead research in this area. The fact that Antigua is now researching wind energy and Barbados is looking into the possibility of developing wave energy indicate the need for more groups of this type. The average citizen is in dire need of information on these new technologies, and also on the possible effect they could have on his life.

Science teachers' associations, science projects and science exhibitions. The oldest Science Teachers' Association is the ASTJ of Jamaica which is over twenty five years old. Since then many countries have also formed these professional bodies for the advancement of science education. At the moment (1981) there are such groups in Barbados, Dominica, Grenada, Guyana, Jamaica, Montserrat, St. Lucia and St. Vincent, and their main out-of-school science activities have been in the area of science projects and science exhibitions.

In some countries such activities are elaborate affairs while in others they represent

small, modest presentations of projects. In the bigger countries, like Jamaica, Guyana, Trinidad and Tobago, and Barbados the exhibitions are sponsored by firms and by industry who help to defray expenses and to present prizes. Usually the exhibits are solicited from schools and other institutions of learning, and every attempt is made to have samples of work from all levels of the system.

Judging is done on criteria such as design, originality, presentation, science content, relevance and use of locally available materials. In Barbados there was a massive exhibition in 1981 and the various projects were of a high standard. Many reflected the concern about alternative energy sources – solar heaters, solar ovens and such related projects were very much in evidence. Jamaica boasts of such elaborate projects as investigations of the effect of effluent from local industry on water supplies, and the ecology of key areas in the country. In St. Lucia where the first science exhibition was sponsored by the St. Lucian Association of Science Teachers in 1980, I was overwhelmed by the pupil and public response that was so evident.

Science clubs and societies. Science clubs are fairly plentiful in the Caribbean region regrettably, however I believe that they are largely ineffective. School clubs tend to be more concerned with extra-curricula activities like photography, music, drama and hiking. The emphasis seems to be more on the idea of using such activities as hobbies.

I believe that the lack of vibrant science clubs is to be lamented, especially when one realizes the immense potential these have.

In some countries, however, there are thriving Astronomical and Horticultural societies. The former are so well organized that observatories, and their relevant equipment, have been set up. In some cases these two sets of societies carry weekly or biweekly columns in local newspapers, in an effort to educate the people. My only misgiving about such articles is in the level or pitch of the submissions. Sometimes the language is so technical and full of jargon that they do not communicate effectively with all strata of society. In a sense they tend to miss a large percentage of the population.

Regional associations for out-of-school science activities. The Caribbean Conservation Association (CCA) is a regional organization set up to develop awareness of the need to conserve the environment. It works out of a Secretariat located in Barbados with most Caribbean Governments as subscribed members.

The Organization does work of an environmental nature. For example, in Barbados, a group of experts drawn from the community work in schools on how best to conserve and preserve the environment. Great care, I think, needs to be exercised in evaluating the impact of CCA's activities.

UNEP through a sub-regional grouping, and as a follow-up to a regional meeting last year, has been involved in setting up local committees for environmental education. In Barbados certain institutions and individuals are actively involved in the study of rodents and insecticides and the effects of these on the environment. This promises to be a very interesting area of endeavour.

Summary

This paper has attempted to show what exists in the Caribbean region in the area of out-of-school science activities. I have attempted to formulate a rationale for out-of-school activities which would, hopefully, give direction and enrichment to the present and future situations.

There is immense potential which well-planned, structured out-of-school activities have, enough to develop the community educationally, economically, socially, and aesthetically. There is a lot to be done still, although much has been achieved already.

Out-of-school science activities in the Caribbean can help to forge links between science and society, and can go a long way towards eradicating the idea that science is magical. Such activities could also give the community at large new ideas about approaching problems and, in time, remove the feeling that any strange phenomenon is the work of some unexplained force. In a few words, a fresh outlook on science could go a long way towards minimising the amount of superstition which is a problem of our region.

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13. OUT-OF-SCHOOL BIOLOGY ACTIVITIES IN SINGAPORE

A CHECKLIST OF OUT-OF-SCHOOL FACILITIES IN SINGAPORE
A. N. Rao
Botany Department
National University of Singapore
Singapore 0511

THE SINGAPORE SCIENCE CENTRE
Leo Tan and Tok-Shiew Foo
Singapore Science Centre
Science Centre Road
Singapore 2260

THE USE OF THE BOTANIC GARDENS FOR NON-FORMAL EDUCATION
Siew Yin Ng
Singapore Botanic Gardens
Cluny Road
Singapore 1025

THE USE OF THE SINGAPORE ZOOLOGICAL GARDENS AS AN EDUCATIONAL RESOURCE
Bernard Harrison, Manomani Thirunavukkarasu and Sui-Hwa Lo
Singapore Zoological Gardens
Mandai Lake Road
Singapore 2575

THE MALAYAN NATURE SOCIETY
P N Avadhani
Botany Department
National University of Singapore
Singapore 0511

1 A CHECKLIST OF OUT-OF-SCHOOL BIOLOGY FACILITIES IN SINGAPORE

A N Rao

Education includes the gaining and assimilation of knowledge, the formation of attitudes and values.

Education is acquired through learning methods which can be divided as:–

(1) Informal education – from life experiences

(2) Formal education – from schools and other institutions of learning

(3) Out-of-school education – from organized systems outside schools.

All three forms are inter-related, contribute equally and supplement each other towards the total knowledge.

Out-of-school and formal education are:-

(1) alike in that they improve upon the informal learning process and promote certain valued types of learning;

(2) different in the institution, execution and subject matter

Out-of-school education as with the other forms of education is part of the life-long education of an individual.

Out-of-school educational facilities are avilable at the following institutions in Singapore. Regular classes are also conducted in some of them.

National Museum
Fort Siloso
Botanic Gardens/Horticultural School
Van Cleef Aquarium
Coralarium
Jurong Bird Park
Singapore Zoological Gardens
Maritime Museum
Singapore Science Centre
Malayan Nature Society and Singapore Institute of Biology.

National Museum

Since 1972, the National Museum has become a museum for the ethnology, history and art in Singapore. It serves the community by way of preserving and disseminating knowledge of not only the artifacts but the artistic and cultural manifestations of such.

It achieves this by means of:

(1) An art gallery education programme (Young People's Gallery);

(2) the National Art Gallery;

(3) classes conducted in the art galleries;

(4) conducted tours of the galleries;

(5) exhibitions, demonstrations and competitions are held at regular or periodic intervals;

(6) opportunities to meet artists;

(7) loan of the kits of the Museum's exhibits – either models or duplicates;

(8) courses;

(9) demonstrations of art techniques;

(10) special workshops;

(11) film shows, meetings and lectures.

Fort Siloso

The Surrender Chamber and supporting photo gallery set in a recreational resort give the public ready access to the recent history of Singapore.

Van Cleef Aquarium

This exists as partly an educational institution. This role, however, is partially hindered by lack of an in-house educational programme but it still has an educational role in the following ways:

(1) Providing a collection of aquatic animals for public viewing;

(2) augmenting courses taught at schools.

Coralarium

A non-formal educational role fulfilled by providing the public with a chance to observe at close range living and dead corals and other kinds of sea life.

Jurong Bird Park

This institution has as one of its objectives that of arousing and creating interest in bird life. This it tries to achieve by the following activities:

(1) Formulating questionnaires on its exhibits to help school children better appreciate the exhibits;

(2) providing institutional memberships to students;

(3) providing film and slide shows.

Maritime Museum

This museum makes its contribution to out-of-school education in the following ways:

(1) Providing exhibition galleries;

(2) providing educational programmes which consist of:–

film shows

slide shows

talks

guided tours

worksheets for primary school students

Singapore Institute of Biology

The membership of Singapore Institute of Biology is open to all working biologists and others who are closely interested in biology. Membership is by election. Monthly and quarterly meetings, seminars, symposia are conducted for the benefit of members and the general public. The proceedings and abstracts of the symposia conducted periodically are published from time to time. The Institute builds a close co-operation between the members of other professional bodies connected with Physics, Chemistry, Mathematics and others.

More detailed information is given for:

a) Singapore Science Centre;
b) Singapore Botanic Gardens;
c) Singapore Zoological Gardens and
d) Malayan Nature Society.

II THE SINGAPORE SCIENCE CENTRE

Leo Tan and T.S. Foo

There has been in recent years a growing demand for out-of-school scientific activities in Singapore. This largely stems from the realisation that science teaching in the class-

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room can perhaps change little from the mainly didactic approach of most teachers, owing to the demands of the school curriculum. It has therefore to be complemented by a variety of both formal and non-formal activities outside the classroom, to help reinforce and exemplify concepts, to cultivate an enquiring mind and arouse scientific curiosity. In so doing, desirable scientific attitudes and skills can be developed which will enhance and facilitate further learning in science.

Out-of-school scientific activities in Singapore

In Singapore, out-of-school scientific activities for young people are organised both within and outside the formal system of education. Outside the school system out-of-school biological activities are organised by numerous organizations and scientific societies and some of these are listed in the checklist provided by Professor A. N. Rao in the first part of this section.

Traditionally, the school club or science society served as the focal point for all out-of-school science activities. School science exhibitions, science talks and meetings, visits to science related places (such as industries, power stations, and so on) were organized to further the scientific interests of students outside the classroom and to provide opportunities for both teachers and students to explore areas of science which perhaps may not have been covered in the normal school programme.

These activities have with time, been expanded and modified to meet the challenge of providing a broad-based science education to the students. These out-of-school scientific activities reinforce classroom lessons in science. They now include tinkering with microcomputers, Singapore Youth Science Fortnight, science camps and nature rambles, science project work like science and technology fairs, quizzes, utilising what the Science Centre provides and others.

Growth of the Singapore Science Centre

Science centres all over the world are playing an important role in meeting the educational needs of society. They are mushrooming everywhere as thoughtful people are beginning to realise the actual and potential benefits of these institutions in creating a greater appreciation and understanding of science and technology in the general public and student population.

The Singapore Centre, since its official opening in 1977, has been attracting an increasing number of visitors and students. The total number of visitors to the Science Centre in 1982 was 347,984. This represents an increase of 23% over the previous year. Over 95% of the schools in Singapore have joined the Science Centre's Institutional Membership Scheme which encourages schools to arrange visits to the Science Centre for exhibit tours and educational programmes. In 1982, over 133,000 students participated in the Science Centre's educational programmes under this scheme. Members of the public and youth are also encouraged to be 'Friends of the Science Centre', a scheme which entitles them to a one year complimentary entrance pass to the Science Centre, free publications and participation in the activities organised by the Centre. In 1982, there were more than 4,000 'Friends of the Centre'. This category of Membership started in 1978 with only 300 Friends. All these figures indicate that the Centre has been playing an increasingly important role as a non-formal educational institution.

The Singapore Science Centre is seen as an institution of learning where a whole field of self-motivating experience in learning through the use of senses and the intellect is encouraged. Instead of the "hands-off" policy, visitors to the Centre are encouraged to touch, manipulate and become actively involved with the exhibits. By interacting with the exhibits, the visitors are able to learn science through exploration and discovery.

The Singapore Science Centre, like other science centres in the world, is less constrained than the formal school-based science system in the types of programmes it can offer. As a result of this, its programmes tend to be innovative and exciting.

Educational programmes

The Singapore Science Centre performs its roles in community-based education by providing specialised facilities which include the following:

i) Exhibit Programme

ii) School Science Educational Programme

iii) Science Publication Programme

iv) Other Innovative Activities

Each of these is described briefly below with respect to biology education.

(i) Exhibit programme

The general philosophy which is followed in the setting up of the exhibits at the Singapore Science Centre is to explain the basic concepts of science and their applications in daily life and industry. It is believed that this is the best way of explaining science and its relevance to daily life to the layman and the students. The Centre has about 5,000 square metres of space devoted to the display of exhibits on pertinent and contemporary issues such as energy, genetics, evolution, ecology and aviation. In all, there are over 400 exhibits to be found in four exhibition halls, namely the Solar Lobby, the Physical Sciences Gallery, the Life Sciences Gallery and the Aviation Gallery. Energy and life are the central themes around which the exhibits have been developed. These themes are appropriate as the present problems in the world (including Singapore's) revolve around the constant supply of cheap energy and the curbing of population growth. The scientific concepts are conveyed in a simple and systematic way through participatory exhibits, graphics, live specimens, dioramas, microcomputers, multi-media presentations and video shows. More than 60% of the exhibits involve direct, active participation. The visitors are allowed to touch and step on the exhibits, turn cranks, push buttons, trace patterns, clap their hands, sing a song, stamp their feet and operate computer keyboards to find out for themselves how scientific principles work.

In the Life Sciences Gallery, the Exhibit themes are as follows:

Cell
The Beginning of Life
People, Problems and Solutions
Genetics
Evolution
Ecology

All of the above themes are related to the biology syllabi of the schools and the exhibits serve as excellent material for complementing the teaching of biology in both primary and secondary schools and junior colleges. The Centre updates and revises about 10% of its exhibits yearly. Apart from permanent exhibitions, the Centre also has temporary exhibitions, each lasting for 3 to 6 months to keep students and the public abreast of latest scientific information.

A brief description of the exhibits in the Life Sciences Gallery is given below.

a) **Cell**: The basic unit of life is illustrated by a cell model magnified 300,000

times. Pre-recorded narrations help to explain the parts and functions of the cell. In addition, there are exhibits on the varieties of cells, mitosis, meiosis and the importance of single-celled organisms in anti-biotic production, agriculture, fermentation industry and protein enrichment products.

b) **The beginning of life**: This exhibition explains the formation and development of a foetus through nine months, climaxing in the final birth of a baby which is shown on a video. It also covers the genetical and environmental factors that affect a child's development during the first few years of his life. Games which provide an excellent source of stimulation for the child are also introduced.

c) **People, problems and solutions**: Attention is focussed on the major problems arising out of the population explosion and introduces the possible solutions. The need for family planning is emphasised.

d) **Genetics**: This exhibition introduces the science of genetics and how knowledge of this can help to present genetically defective babies.The genetics of plants and other animals are also included.

e) **Evolution**: The evolution of plants and animals is traced with greater emphasis on man. There are also live specimens, a multi-media show and video shows to illustrate the adaptations and evolution of plants and animals that have ensured their survival.

f) **Ecology**: This exhibition illustrates the living and non-living components of the ecosystem and man's impact on the environment.

The Centre provides exhibit ***guided tours*** for groups of 30 or more persons from Tuesdays to Sundays. These tours have to be booked in advance and worksheets based on the exhibits are available upon request. The purpose of the worksheets is to enable the visitors to evaluate their knowledge gained from the exhibits and also to serve as feedback to the Centre for any follow-up action.

Exhibit workshops for teachers are also organised to familiarise teachers with the facilities of the Centre and to impress on them the importance of the Science Centre, as a resource Centre. In this way, teachers can make use of these exhibits to reinforce their classroom lessons. Furthermore, principles and concepts taught in class which are beyond the teachers' means to provide adequate explanation, can be effectively reinforced through the use of such 'visual - tactile' aids. Through these experiences, fundamentals learnt can be retained longer by the pupils and serve more than just learning to pass examinations.

(ii) School Science educational programme

The Centre runs an active educational programme for students, ranging from primary school pupils to pre-university students and teachers. This programme aims to enrich and complement the school science syllabus by means of first-hand observation and direct experience outside the classroom. It provides opportunities for deeper insight and greater understanding to those areas of knowledge which usually are merely read and discussed but seldom experienced. It includes a series of science talks, lecture demonstrations, laboratory classes, workshop, seminars and film shows. Seminars and workshops are also frequently held for teachers. A summary of the topics on life sciences offered to schools is given below. It may be pertinent to note that the schools are consulted on the choice of topics to ensure there is no duplication of effort.

I PRIMARY SCIENCE EDUCATION PROGRAMME (LIFE SCIENCES)

Lecture	Leaf patterns and leaf shapes
Demonstrations	Fruit dispersal and seed germination
	Life cycle of a chick
	Life cycle of a frog
	Plants with weak steam
	Non-flowering plants
	Vegetative propagation
Laboratory	Animal and plant characteristics
Classes	Food chains
	Freshwater aquatic community
	How to use the microscope
	Living and non-living things
	Study of earthworms

II SECONDARY SCIENCE EDUCATION PROGRAMME (LIFE SCIENCES)

Lecture	Characteristics of living organisms
Demonstrations	Asexual and sexual reproduction in plants
	Development of a frog
	Conservation of water in plants & animals
	Diversity of plant and animal life
	Know your genes
	Vegetative propagation
Laboratory	Adaptations in plants and animals
Classes	A pond community
	Diffusion and osmosis
	Ecology of a garden
	Life under a microscope
	Classification of plants and animals
	Decomposers
	Food relationship amongst living things
	Cells and tissues
Science Talks	Strategies of animal world
	The microbe : friend or foe
	Nature's architects
	Miracle genes
	Symbiosis
	DNA
	Survival of the fittest
	Know your body

The laboratory classes and lecture demonstrations serve to consolidate students' learning by providing direct experience and handling of materials. In topics like Ecology where concepts of inter-relationships are involved and there is difficulty in schools in supplying the students with actual experience of the habitats and materials, the centre can provide the facilities for out-door ecological studies.

The Centre has set up an Ecogarden to provide facilities for out-door biological and ecological studies. The Ecogarden is an ideal site for first-hand observations of our local plants and animals as well as the study and understanding of nature of work and basic ecological concepts. In the Ecogarden, there are ponds where students and teachers can study more closely aquatic life; local fruit trees; common roadside trees; ornamental shrubs, herbs and climbers; a mini-animal farm with ducks, chickens, rabbits and tortoises; a vegetable patch and a leaf litter corner where they can learn about the importance of decomposers in maintaining the balance of nature.

The Ecogarden is open only to students and teachers. These organised school groups can visit the garden or participate in a laboratory class through a pre-arranged scheme with the Centre. When they arrive they are immediately taken to the laboratory where one of the Centre's scientific officers shows them slides, gives out worksheets and explains to them what they can possibly find. Rules of conservation are also spelt out. The students are then let loose in the garden, armed with nets, plastic bags and containers to collect specimens.

The Centre is in the process of setting up an open-air laboratory right in the garden so that the students and teachers can study their specimens on the spot. This Ecogarden is also used as a training ground for primary and lower secondary school teachers on the various aspects of ecology. Since 1979, the Centre has conducted numerous workshops on Ecology for primary and lower secondary school teachers. Each 3-day Ecology Workshop is developed to acquaint teachers with basic ecological concepts through hand-on experiences, enquiry, discovery and practical investigation. In addition, teachers are also taught to construct simple apparatus and teaching aids to enhance their classroom teaching. The Centre continues to develop such workshops for teachers to introduce to them the philosophy of experimental science and hand-on experiences.

(iii) Science publication programme

The Centre produces the following publications:

a) **Singapore Scientist**: This is a quarterly magazine published and distributed to schools and the general public. It contains pertinent and contemporary articles on the latest developments in science and technology. There is also a special section for the students where simple projects, games and quizzes are incorporated to supplement science learning.

b) **Wallcharts**: These are colourful and illustrative broadsheets on the various scientific topics. They contain basic information on the important science concepts and are well presented by means of illustrations, puzzles and experiments. A total of 15 broadsheets have been produced and they include topics such as Energy, Magnetism, Food chains, Insects, Life cycle of a frog, Life cycle of a chick, Singapore birds, some roadside trees in Singapore, Singapore shells, Common garden insects, Freshwater fish, etc. These wallcharts are primarily used by both primary and secondary school teachers as teaching aids.

c) **Science Centre News**: This is a bi-monthly newsletter distributed to all schools and 'Friends of the Centre'. It contains information on the current and latest activities of the Centre. It serves to inform teachers of the facilities and programmes of the Centre and hence helps them to make advance planning of their visits to the Centre.

d) **Guide books**: The Centre is publishing a series of guide books on local flora

and fauna. They help to familiarize teachers, students and the interested layman with our plants and animals. "A guide to pond life", the first in the series has been very well received by both students and teachers.

e) **Slide packages**: These are being produced in response to requests from teachers for more teaching aids and audio-visual software.

iv) **Other innovative activities**

The Centre also collaborates with the Science Teachers' Association of Singapore, the Singapore National Academy of Science and other scientific organisations to organise innovative activities to promote science education in Singapore. Some of the activities include the Singapore Youth Science Fortnight, Workshops for teachers, Science Camps, Science Club Activities and Seminars.

The Singapore Youth Science Fortnight, since its inception in 1978 has become a national event in Singapore as more than 100,000 students and teachers take part in the various activities each year. The activities of the Fortnight provide our youth with an opportunity to appreciate that science is a living and dynamic body of knowledge and not a subject where one regurgitates facts and formulae. Some of the activities of the Fortnight include Science Fair, Science Telematch, Science Fiction Writing Competition, Exhibition on Energy Resources, Science Olympiad, Science Fun Fair, Nature Camp, and Workshop for Science Teachers. New innovative activities are introduced every year.

The three day Nature Camp of the 1983 Youth Science Fortnight was organised for about 140 primary school pupils to discover how nature works at the Science Centre Ecogarden. The Camp also aimed to generate in our youth an awareness of the wonders of nature and the need to conserve the environment. In the past, science camps were also organised for pre-university students. The participants had to study different ecosystems found in Singapore. The fields of study included the flora of reclaimed land, the ferns of the Bukit Timah Nature Reserve, ecology of a reservoir and ecology of a coral reef. These camps readily demonstrate to our youth that book knowledge alone is inadequate for their understanding of science and the world around them.

The Singapore Science Centre and other scientific organisations have recently introduced a special badge scheme for our budding scientists. This is to encourage pupils to work out science activities on their own. Once they have successfully completed a set of activities, they are presented with badges which proclaim them to be young botanists, zoologists, entomologists, ecologists, meteorologists, astronomers, geologists, and so on.

These science club activities are designed to motivate pupils to experiment with nature and discover things for themselves. For example, young zoologists may be expected to visit the Science Centre and make notes about some of the animals found in the exhibits or to make casts of the feet of three different kinds of birds using plaster of paris or to record the sound of a bird. They are also expected to give talks to their classmates and write stories and poems on animals.

Conclusion

The Singapore Science Centre continues to introduce new programmes and innovative activities to promote science education through the unique concepts of 'hands-on' and discovery. The schools, various scientific organisations and the Science Centre will find more ways to work together for the improvement of science education in Singapore and for the benefit of our youth and society.

III THE USE OF THE BOTANIC GARDENS FOR NON-FORMAL EDUCATION

Siew Yin Ng

Shortly after the founding of Singapore in 1819, Sir Stamford Raffles started Singapore's first Botanic Gardens in 1822, on what was known as Government Hill at Fort Canning. The Gardens was mainly planted with economic species such as nutmeg, clove and cocoa. These Gardens were however abandoned in 1846. Thirteen years later, the existing Botanic Gardens was established by an Agri-Horticultural Society in Singapore on a plot of land granted by the Government. In its 120 years of existence, the Botanic Gardens has developed into one of the foremost tropical gardens in the world, due to the efforts of our early directors who included such illustrious names as H. Ridley, H.M. Burkill, E.J.H. Corner and R.E. Holttum.

The principal work carried out by the Botanic Gardens can be grouped under three main headings, viz, botanical, horticultural and educational, with inevitably some overlapping between them. In addition to these functions, most botanic gardens are open to the public and thus provide the facilities of a public park.

A museum of living plants

The primary aim in our educational programme is to stimulate interest and disseminate information to the receptive visitor. We have as large a collection of living plants as it is possible to grow without sacrificing an attractive layout. The Gardens is in fact a great museum of living plants. All permanent plantings are labelled and these labels form the basis of our permanent information system.

There are three types of labels:–

(a) plants for temporary displays which are changed regularly are provided with simple dymo tape labels.

(b) the bulk of the plant labels are handpainted ones on 6" x 4" pieces of wood and placed at the base of the plant. These labels provide the scientific name and family together with the country of origin. If there is a common English or vernacular name, this may be added.

(c) economically important or interesting plants or groups of plants are provided with informative labels – large labels carrying a paragraph or two of text.

Anyone wishing to identify plants and flowers can easily matched their specimens with those in our grounds. Those who find difficulty in doing this can approach our officers for assistance.

As a further aid in plant identification, there is a valuable collection of some ½ million herbarium sheets. These dried mounted specimens are mainly confined to plants of this region, but there is also a separate section for cultivated plants. This method of plant preservation is a useful way for keeping specimens for study at a later period when the plant is no longer available or when flowers or fruit are absent. It is also an easy way to verify the identity of plants as one can simply check freshly collected specimens against an authenticated sheet. A herbarium collection can be kept by a class or by interested individuals. This would encourage the students to learn the names of the plants as in the process of preserving the specimen they would have to note down not only the names but also the characteristics of the plant. All these data can then be kept for future reference. The Botanic Gardens could arrange for demonstrations for anyone interested in learning how to prepare proper herbarium specimens.

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For those interested in the practical aspects of plant care and propagation, talks and practical sessions can be specially arranged. These could include or concentrate on several aspects of horticulture such as choice of plant material, preparation of site, types of soil media, manurial requirements, pest and disease control, propagation by cuttings, marcotts, grafting and so on. These demonstrations are useful supplements to the formal classroom lectures and are a far more effective way of communicating such information to the student.

A rather more specialized display suitable for upper primary and secondary school students can be found in the orchid section. Here, the visitor contrasts the relatively insignificant flowers of most of the wild species with the flamboyant riot of colours produced in the hybrids. It is interesting to trace the parentage of some of the hybrids and to observe the transmission of dominant traits through the generations. Observations could also be made on the mode of growth – whether the plants are epiphytic or terrestrial, monopodial or sympodial, sun or shade-loving – and to correlate these factors with the way they are cultivated. The orchid flower is a very special one, exhibiting a diverse range of form and colour and yet maintaining certain characteristics which distinguish it from all other types of flowers. A simple yet effective lesson in taxonomy is conveyed in observing them closely. Photographs showing the stages in orchid pollination and seed culture are also displayed and demonstrations on this aspect of orchid culture can be arranged.

Nature ramble

The whole Botanic Gardens is one huge nature ramble comprising of innumerable lessons. Some of these described are below:

(a) The Marsh Garden was constructed in a low-lying area of the grounds which was constantly subject to flooding. A whole community of hydrophytes can be found here, some deliberately cultivated and others colonising the area naturally. Besides the plants, a variety of aquatic and terrestrial animal life can be found. A complete lesson in marsh life is available here.

(b) There are two Lakes which could provide a series of limnological surveys. One very obvious observation is the difference in depth in them and the types of aquatic plants which have sprung up consequently. For example, the newer second lake abounds with ***Hydrilla verticillata*** which is virtually absent in the first lake.

(c) There are several groups of xerophytic plants on display. The characteristics of these plants and the range of form available can be studied at the two Sun Rockeries and at the Cacti and Succulent House. Also obvious are the edaphic and climatic requirements.

(d) Shade-loving plants can be found in most nooks and corners in the Gardens. There are however two main structures housing such plants. These are the Tropical House and the Plant House. Most of these plants have gained horticultural prominence through their use as indoor plants and some of them have beautiful leaf shapes and markings. They fall mainly within a few families such as the Araceae, Marantaceae and Liliaceae and the diversity in forms exhibited is extremely interesting.

(e) A Fernery has also been constructed near the Plant House and in this little dell grows our local and some introduced fern species. The Elephant Fern ***(Angiopteris evecta)*** and lowland tree fern ***(Cyathea latebrosa)*** are two

interesting species among this group of Pteridophytes. Again useful ecological observations can be made on these plants.

(f) A completely artificial environment has been created in our Temperate House. Conditions conducive to the growth of species occurring at higher altitudes or in more temperate climates have been simulated here. Visitors are not permitted to enter the house but can view the exhibits from a verandah running around the octagonal house. We have been successful in inducing flowers in some higher altitude orchids, camellias, azaleas and cyclamens and hope to cultivate many more species in the future. This exhibit provides an opportunity for our visitors to see what they may have only read about in literature.

(g) The Gardens boast of a piece of primary jungle within its boundaries. This little plot of 4 ha is the only primary jungle in Singapore outside of Bukit Timah Nature Reserve, and is unique in being situated so close to bustling city life. Although the encroachment of civilisation into the jungle is unavoidable in such a small area, we try to preserve it in as undisturbed a state as possible. Large trees of commerical timber value are still standing and a certain amount of forest stratification can still be found. Even though this jungle can no longer serve as a typical example for the study of Lowland Dipterocarp Forest ecology, it still provides a useful insight into the kind of floristic and a minal species which exist in such a habitat. Many Singaporeans have no first hand knowledge of the jungle–we offer them as easily accessible spot to gain this experience.

(h) There are a large number of interesting plants to capture the attention of even the most reluctant visitor. Where it is difficult to remember morphological details through words and unco-ordinated bits and pieces of twigs, leaves and flowers, it is easy to create a lasting impact by seeing the tree as a whole and associating it with distinctive features such as fruit, bark, height, smell and so on. For example, the majestic Tembusu ***(Fagraea fragrans)*** with its towering crown and low spreading limbs is an unforgettable sight in the Gardens and particularly so if the child is told that Daddy or Teacher used its twigs for catapults and that is timber is hard and strong enough to be used for wooden chopping boards. It is also impressive to hear that the tree has been standing for close to a hundred years, that when it flowers twice a year, flocks of birds and fruit bats congregate on the branches to feed on the juicy, red berries. Other trees of interest are the Monkey Pot Tree ***(Lecythis ollaria)***, Cannon Ball Tree ***(Couroupita guianensis)*** and Sausage Tree ***(Kigelia pinnata)*** with their curious large fruits, the Banyans ***(Ficus spp.)*** with their supporting aerial roots, the Chewing Gum Tree ***(Dyera costulata)***, the Upas Tree ***(Antiaris toxicaria)*** where the sap is used for poisoning arrowheads, the Nibong Palm ***(Oncosperma flamentosa)*** with tall thorny stems used for kelong stakes and the Sago Palm ***(Metroxylon sagus)*** where the pith is used for sago production. These are only a small percentage among the thousands of trees, shrubs, climbers and herbs in the Gardens.

One of the most popular uses of the Gardens in recent years is in nature rambles and orienteering. This is one successful way of teaching the recognition of plants without the student realizing it.

So far many school groups visiting the Gardens only use our lawns as a picnic ground. A trip to the Botanic Gardens can be much more than a pleasurable end-of-term outing. If an organised effort is made, we offer to show Education Officers around the Gardens and to point out features of interest to them. They can then disseminate this information to their students so that future visits may be exciting, informal lessons in biology.

IV THE USE OF THE SINGAPORE ZOOLOGICAL GARDENS AS AN EDUCATIONAL RESOURCE

Bernard Harrison, Manomani Thirunavukkarasu and Sui-Hwa Lo

Informal education differs from formal education in that there is no set syllabus to follow and no assessment of the knowledge absorbed once the formal tuition period is over. Hence, informal education is far closer to the 'real to life' situation of learning where one retains only what one is interested in, unless facts are learnt by rote. The Singapore Zoological Gardens can be regarded as a 'living classroom' as long as we can stimulate the interest and imagination of our visitors by offering them subjects of interest, backed up with the appropriate amount of scientific and educational information.

Before proceeding to identify the information available to Zoo visitors, and the methods of dissemination, the background information about the Zoo will be briefly outlined.

Background

The Singapore Zoological Gardens, unlike many other mainstream zoos in the world, (because there is a bird park, aquarium and coralarium in Singapore) confines itself to a large extent, to the display of mammals and reptiles. Excessive duplication of exhibits, for practical reasons, seems pointless on such a small island. This is not to say however that there are no birds or fish displayed in the Zoo, but they are used more as 'back up' animals to a main exhibit.

The Singapore Zoological Gardens which was opened in June 1973 is a public limited company, wholly owned by the Government of Singapore and has a collection of some 1,600 animals representing about 160 species. There has been an average visitor attendance of over 862,000 per annum of which 64% are adults, the remaining 36% being children. Our Education Scheme introduced in 1976 has so far received 661,205 students to date (March, 1984) in organized group visits. On a yearly average we received 76,000 students (which is 16% of the total school population) under the School Friends of the Zoo Scheme.

Since 1979, two trained teachers deputed by the Ministry of Education are on attachment to the Zoo to implement the educational programmes for visiting students.With the above background, the other information disseminated at the Zoo is given below.

Disseminated Information

The Singapore Zoological Gardens is an institution which maintains and displays viable colonies of animals for the purpose of education, recreation, conservation and research.

The animals are displayed employing modern techniques which make them easily visible to visitors in as natural a setting as is possible. This is to allow the visitors to

appreciate the natural size, shape, colouration and activities of the captive animals and how they can adapt and harmonize with their environment.

By doing this we allow the visitors to be their own teachers, absorbing a certain amount of information from just looking, because their attention, and hence their interest, is captured by one or other characteristics of the animals. This leads to self questioning and they seek for answers supporting information at the enclosure. If for some reason they cannot deduce the answers themselves, they can turn to friends or the keepers with their queries. The answer is more likely to sink in because the visitor was the one to ask and find out. He or she was not 'spoon-fed' with the 'facts'.

For the average visitor, answers to questions like, 'What is it called? Where does it live? Native or foreign? What does it eat? How many babies does it have?' are the norm. They learn about certain groups of animals and since we try to maintain a fairly representative collection of the mammals and reptiles, they will leave, with a clearer general knowledge of these animals. This is education in simple zoology. We hope that they will learn more about the animals eg. touch a snake that they have always thought was slimy or identify with them and see their natural beauty eg. shake hands with an orang utan which they always thought was fierce, and by watching antelopes, monkeys, cats, bears and sealions romping around in their enclosures perhaps come a little closer to respecting the animals that share the earth with us, find out that they have personalities, and have mother-infant bonds and feelings. We hope with this realization, the ground work for the second, perhaps more important part of our message to them will be laid.

Once society is more enlightened about concepts such as ecology and conservation, more money can be channelled and more important decisions affected in a pro-conservation light. Once society realizes that an ecological balance of animals, plants and the natural elements is vital for our own existence, that if we do not conserve animal species they will become extinct, that there is more to life than purely making money irrespective of the consequences of destruction of habitats, upset of ecological balance,pollution and degradation of the natural environment, then and only then can we, along with the other bodies who work towards these goals, feel that our long term educational objectives have been fulfilled.

Dissemination of Information – For the Public in General

We are able to disseminate information in a variety of different ways at the Singapore Zoological Gardens. The casual visitor, as he or she enters the Zoo, can obtain a leaflet which offers a map, some basic descriptions of the animals, a programme of the events that will take place on that place on that day and the various facilities that are available.

We also publish booklets on new animal exhibits which contain information which serves to give a good general background of the animals to the visitors and explain the extent of complicated technology that is used in organising an effective exhibit. Posters with an education bias are produced whenever new exhibits are opened. These are sent free to all schools and sold at the souvenir kiosk at the entrance.

Each enclosure is equipped with a standard animal legend. These are carefully designed to allow the visitor, at a glance, to extract certain 'bits' of information from them. There is a distribution map, a graphic of the animal and various headings which cover such topics as feeding habits, reproduction and social structure, each followed by a concise line of essential information. The visitor may find the answer to his question without ploughing through great lengths of text, which would be discouraging and time consuming.

At some enclosures there are also graphic signs emphasizing one particular aspect of a species by comparing this aspect in two species of animals. Topics such as camouflage, colouration, social structure or the reasons for special adaptations of the body are covered in these signs.

At certain enclosures there are also taped-recorded messages where, by the press of a button, the visitor is supplied with a concise two minute description of the animal in question. Here, we are concerned with the more interesting features which are not covered by the legend or graphics.

Many of the 4,000 trees in the zoo grounds are labelled with both the scientific and common names, and legends. Some of the plants which are studied in the school science syllabi are accompanied by detailed drawings and pertinent information.

The visitor could tour the Zoo comfortably by taking a tram which is equipped with a taped commentary giving a general description of the Zoo and the animals in the enclosures along the tram route.

Each day there is an Animal Showtime at 3.30pm (on Sundays and Public Holidays there is an extra show at 11.00am). Here a commentator conducts a 45 minutes programme. The sealions, orang utans, snakes and elephants 'perform' for the visitors. This performance is a serious educational show and not for fun. The sealions and elephants perform a repertoire of tricks to demonstrate their intelligence, agility, strength and grace. The orang utans open coconuts to show their intelligence and strength and the snakes are displayed for the public to touch. The commentary throughout covers the basic zoology of the animals and other interesting snippets of information. The shows serve to capture the public's attention and hence, offer us a captive audience for education.

After the showtime the public are at liberty to touch the animals and ask the keeper questions about them. This contact is important and in our Children's Zoo the public can touch, feel and hold animals. Contact serves to reinforce the bond between man and animals.

Visitors who are interested can also opt to have breakfast or high tea with our orang utan Ah Meng or her daughter Medan. This is a whole new educational experience recommended for everyone.

Dissemination of Information – To Visiting School Groups

At present we conduct free slideshows and talks at the Zoo Theatrette for schools who are institutional members of our Friends of the Zoo scheme. More than 68% of Singapore schools are institutional members of the Zoo, where with a payment of a nominal annual subscription, the students and accompanying teachers can visit the Zoo free throughout the year and receive personal attention by our education officers.A total of 1,073 groups consisting of 76,000 students and teachers visited the Zoo under this scheme in 1983 and 10,574 visitors attended talks and slideshows at the theatrette. Booking however must be made in advance of the visit for obvious reasons and to make necessary arrangements.

Students are supplied with free guidesheets which consist of simple questions and multi-choice answer quizzes based on various biological topics. The theory to the guidesheets is observation and deduction as the group walks around the Zoo. There are a variety of topics covered by the sheets which are relevant to the biology syllabus for various levels of primary and secondary students.

Hopefully, we shall be opening a new Education Scheme Workshop soon, to allow for a more comprehensive orientation of students before their tour of the Zoo, At present however the students are given a slideshow and a discussion on a specific topic given the relevant guidesheets, followed by a tour to the part of Zoo where they will observe the animals and find answers from the legends at each enclosure.

We publish a quarterly educational magazine called Zoo-Ed which is designed for students of primary and secondary levels, supplying useful information on the biology

syllabus in the form of articles, graphics, puzzles and wall charts. This is sold directly to students at S$0.80 a copy.

Educational slide teaching kits on Zoo animals and plants are available for sale to school. Even the bones of animals that died in the Zoo are treated and used as teaching material in Zoo – conducted sessions. Some are sold at a nominal price to schools for use in biology lessons. Besides all these aids for information, there are two categories of Friends of the Zoo Scheme for primary and secondary students. Friends of the Zoo are entitled to free all-year-round admission, receive our quarterly Zoo-Ed magazine and a bi-monthly newsletter which keeps them informed of happenings and new developments at the Zoo. They are invited to talks and outings at the Zoo where one of the Zoo's senior staff will give a short talk on topics relating to Zoos or nature. After that the speaker and other key officers will be available to mix with Friends and answer their queries.

The disabled are not forgotten. Ramps have been constructed at most enclosures for those on wheel chairs. A Zoo Guide Book produced in braille with embossed pictures of animals on plastic sheets was produced to help the blind 'feel' the animals.

Conclusion

The Singapore Zoological Gardens is by no means a static place when it comes to informal education, since education is one of our main objectives, it is our duty to serve the public, both the casual visitors and the organized groups from schools. Few people want to be consciously educated. If we run a large advertisement in the press which reads "Come and be educated at the Singapore Zoological Gardens", we would not attract many visitors. But if we run an advertisement which says "Come and see our new polar bears and watch our animal showtime", we would. And that is the great difference between formal and informal education.

School teachers are learning to use the Zoo as a resource centre and that is the whole point of our existence.

Once we get visitors into the Zoo, be them students or the general public – once we have seen that they are contented, have enough to eat, drink, enough shade, toilet facilities, enough animals to feel they are getting their money's worth – we have a captive audience and then, one day, perhaps in one, two or three generations from now, they will show a little more understanding, a little more respect and a little more concern, for the animals and the environment that we all share.

V THE MALAYAN NATURE SOCIETY

P N Avadhani

The Malayan Nature Society in its present form has been in existence for the past 37 years catering to amateur naturalists and professional biologists alike. It is dedicated to promoting public interest and education in the natural history of the Malayan and South East Asian region. It is deeply concerned with the conservation of wildlife and all natural resources. In Singapore, the interests are public education and conservation of existing reserves and parks.

At present, the membership of the Society is just under 2,000 representing all walks of

life cutting across all social and economic levels – the common factor between them being an interest in nature and a desire to know more about the living and non-living components.

The Society is very active in conservation education and the publication of several books that would interest naturalists and others. The publications include:–

(1) A quarterly journal called the *Malayan Nature Journal,* which contains reasonably authoritative and scientific articles on matters relating to flora and fauna, their habitats and the value of conservation in the region.

(2) In addition to the Journal, the Society also publishes another quarterly called *The Malayan Naturalist* which contains news items, short notes and other matters related to Biology and conservation at a level more appropriate to the education of the layman.

(3) The Society publishes monographs on different topics and these include:–

1) *Introduction to Malayan Birds* by G C Madoc.
2) *Pocket checklist of the birds of Malaya and Singapore.*
3) *The Birds of Borneo* by B E Smythies.
4) *An illustrated key to Malayan Hard Corals* by A G Searle.
5) *Malayan Wild Flowers* by M R Henderson. Vol 1 Dicotyledons and Vol. 2 Monocotyledons. Appendix by B C Stone free with volumes or $1.00 per copy.
6) *The Butterflies of the Malay Peninsula* by Corbett and Pendelbury; 3rd ed. revised by J N Eliot.
7) *A guide to Batu Caves* ed. E Soepadmo and Ho Thian Hua.
8) *Guide to Kinabalu National Park.*
9) *Guide to Taman Negara.*
10) *Checklist of Endemic Trees of the Malay Peninsula* by F S P Ng and C M Low.
11) *Moths of Borneo with special reference to Mt Kinabalu* by J D Holloway.
12) Post cards – Taman Negara (set of six).
13) *Magnificent Plants* by Yong Hoi Sen.
14) *Poisonous Snakes of the Malay Peninsula* by Lim Boo Liat.
15) *Proceedings of Symposium on Biological Resources and National Development* ed. E Soepadmo and K G Singh.
16) *Ular-ular Bisa di Semenanjung Malaysia* by Lim Boo Liat (Bahasa Malaysia).
17) *Mangrove forests of the Malay Peninsula* by Watson Mal. For. Record No. 6, 1928.
18) *Moths of South East Asia* by H S Barlow.

All these publications have been useful in imparting biological knowledge to the common man, students and members of the scientific community. The students and scientists consult these works frequently and some of the publications on birds, wild flowers and others are the only published works easily available on the

subjects. Depending on the funds availability or donations received, the Society also provides financial assistance to relevant research projects.

The educational programmes of the Society are specially designed for schools. Different pamphlets and slide packages are distributed and used in schools as supplementary teaching aids and materials.

In Malaysia the Society has 12 branches in most of the States and each branch organises regular indoor meetings on topic related to natural history and outdoor meetings to study and enjoy nature.

In Singapore there is an autonomous branch since 1954 with a current membership of about 500. The Singapore branch offers at least two events per month: one outdoor trip, either to Malaysia or within Singapore, ranging from one day to long weekends, and one indoor lecture, usually illustrated with slides or film. Occasional extra meetings such as special movie nights, are also arranged, free of charge. Members are informed of the programme, as well as other news, in a monthly newsletter mailed to them. The meetings are usually attended by 40–100 people. The branch also holds informative seminars periodically on suitable subjects attended by the lay public, biology teachers, advanced pupils of schools and professional biologists. The University staff collaborate with outsiders in organising the various programmes. Thus the Society helps in educating the lay public on conservation and acts as a clearing house for information on related topics.

The membership is inexpensive at Singapore or Malaysian dollars 25.00 per annum for ordinary members with an entrance fee of $5.00.

14. OUT-OF-SCHOOL SCIENCE ACTIVITIES IN THE FEDERAL REPUBLIC OF GERMANY — AN HISTORICAL NOTE

Gerhard Schaefer
Faculty of Education
University of Hamburg
Von-Melle-Park 8
2000 Hamburg 13
Federal Republic of Germany

The necessity to bring children and nature close together has been frequently pointed out by educationists, mostly because of the "high motivation" which is said to be developed by such events. The question is why natural things (which certainly are not always pleasant) are able to motivate children to such a degree? It must be assumed that children have a deep desire for something which is present in nature but not in the artificial human civilization, even if civilization is producing so much "happiness" by films, books, television. It is the author's strong conviction that it is just ***physical reality***, in the full context of sensory experience, which young people feel a need for, and which, in contrast, cannot be offered by any kind of human imagination with its subjectivity, its uncertainty, its mistakes. So the search for physical reality is apparently based on the deeper desire for security; security not in the sense of plain public welfare but in the sense of INTEGRATION OF ONE'S OWN PERSONALITY which cannot be achieved without nature, as nature is not "outside", but also inside and has to be internalized in order to find identity and security.

Another reason for the strong motivation gained by out-of-school activities is obviously activity as such. Young people have a strong drive to move, to be active, to show initiative. So a step out into nature normally meets their motor needs.

Not all our students and young adults, however, are really motivated by "nature", and not all of them feel a drive to move. Quite a considerable number generally feel bored by observation of plants, lower animals, stones, chemical substances and so on, and quite a number, especially at the age of puberty and afterwards become lazy and unwilling to move.

So they prefer to stay at home or in a pub, in a civilized environment, listening to taped and recorded reality and reading paper reality. They rather like to listen to and read about nature than to encounter nature directly. What is going on in such young people? Are they totally missing the above mentioned need for integrating nature into their personality, or are they just misled in their feelings, not being aware of a deeper voice demanding confrontation with physical reality? In either case it should be a matter of educational research to analyze the factors responsible for the student's attitude toward nature. In these investigations not only a distinction should be made between "nature outside school" and "nature inside school" (e.g. in form of physical/chemical experiments, or observation of living material in the classroom), but also between out-of-school education during school time and out-of-school education before, which in the following discussion will be generally called "pre-school education".

In this country the demand for out-of-school education is about 80 years old. At the beginning of this century there was a strong pedagogical movement called

"jugendbewegung" (Youth Movement) leading young people out of their homes into nature. Thousands of them, in the weekends and on holidays, set off in groups to hike through forests, mountains, fields discovering nature by means of their legs and joining in the concert of natural voices with their own voice, singing, talking, laughing, ('Wandervogel'). This movement, however, was largely based upon emotional grounds; enthusiasm about nature, love for nature, the empathic feeling with animals, trees, brooks, and clouds. So it cannot be compared with an "out-of-school science activity"; it rather was an AFFECTIVE discovery frequently an animistic or even anthropomorphistic approach to nature (which is said to have been a specific trait of Germans in that time).

Also some leading pedagogues in the twenties (Kerschensteiner, 1928) analysed the educational value of science, proposing an intensive and manual confrontation of children with natural objects, either in school or out of school. However, the time had not yet come to really break up the barriers of school and take students out into field work, into systematic "study of nature WITHIN nature." This was partly because the philosophy of the Youth Movement was not accepted for general education by school authorities; partly because the Youth Movement after the First World War split up into several, politically diverging groups weakening the movement; and partly because in the time between the First and the Second World War still too much emphasis was put on educational objectives like discipline, obedience, duty, industriousness, and mass of knowledge for which in-school education seemed more favourable than out-of-school education with its more open, more flexible way of teaching.

In the time between 1933 and 1945, under the National Sociaiistic Government, there was again a strong out-of-school activity to be noted in the Hitler Youth, but still, this was not mainly concerned about a scientific perception of nature but more about emotional and muscular interaction with it. Special emphasis was laid upon hard pre-military training, and on adaptation to an identification with nature. However, "Identification" with an object should mean knowing the object very well before, that is starting with scientific observation which removes prejudices instead of inducing them. So this movement resulted in a misled identification, a "biologism" without reliable biological background with all its political consequences.

After the Second World War the way out from school into nature seemed impeded by reminiscences of the past. So it was difficult to start a new pedagogical approach in this direction. Regular and compulsory "School Hiking Days" ('Wandertage'), once a year, were nothing but a drop of water on a hot stone, but still they showed very clearly how many children can be motivated to experience nature through all their senses, if they are taken out from the "Laboratory world" called school. In some smaller towns, since the end of the 60s, biologists established "Waldlehrpfade" (Nature Trails), where students could walk through nature, mostly forests, following a prescribed way, guided by sign boards and maps with the names of plants and animals to be observed. Other attempts to take students out of school were: working in school gardens, organized visits to zoological gardens in cities or Safari zoos, or a one week's stay at a "Schullandheim" (School's Rural Hostel), where students were able to make systematic biological observations in nature (if incidentally the accompanying teacher was a biologist!).

Since the beginning of the 1970s, first steps were made to establish Field Study Centres ("Okologische Stationen") for different age groups, similar to the British model. Furthermore, for younger children "Youth Farms", "Active Playgrounds", "Adventure Playgrounds", or "Robinson Playgrounds" were established according to the British and Scandinavian examples.

In all these centres the basic pedagogical idea is to make children acquainted with nature through *primary* experience instead of only secondary experience by books, films, television. It is expected that this kind of direct contact with nature, especially

with the living part will reduce the hecticism of modern civilized life and will help young people to find for themselves by integrating senses and muscles, that is sensory perception and willpower, into their personality.

Thus the one-sidedness of intellectual training which is still prevailing in our schools will hopefully be overcome. However, how many children do we reach with such attempts of out-of-school education? How effective is this idea in West Germany?

Still most of the above mentioned enterprises are run on a private basis. Very few are initiated by the government. If they are financially supported by the state or local authorities, the support mostly is small and covers only part of the maintenance costs. The idea is encouraging and many politicians realize the necessity of out-of-school education centres, but the priority in regional budgets of the 11 West German "Bundeslander" is still given to other sectors, and within the field of education to universities and normal schools.

The possibilities of out-of-school education in FR Germany can be roughly assessed by the following figures:

According to a recent documentation by Schroer (1980) there are:–

33	Zoological gardens; among these 21 with special educational programmes
28	Aquariums, vivariums, exotariums; among these 9 with special educational programmes
156	Wild deer forests (reserves)
42	Bird parks, ornithological stations, and bird reserves
74	Botanical gardens and plant exhibition parks
324	Science museums
59	Nature parks and 17 large nature reserves
24	Ecological Stations (Field Study Centres); 18 for a stay of several days, 6 for 1-day visits
3	School Biological Centres and Pedagogical Centres
7	Nature trails with a strong challenge for self-activity of the students.

These figures may produce an optimistic view on the situation of out-of-school science education in West Germany. However, they only show *possibilities* for such an education, and cannot give any evidence of reality, that is of the degree to which these possibilities are used by teachers and school administrators.

There are no figures yet about this, and the vast number of about ten million young Germans going to schools, colleges, or universities make it likely that not many of them will ever have a chance to enjoy out-of-school activities in such centres.

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FOUR

CONCLUSION

15. THE PLACE OF OUT-OF-SCHOOL SCIENCE IN GENERAL EDUCATION—CURRENT TRENDS AND FUTURE PROSPECTS

G. Rex Meyer
School of Education
Macquarie University
North Ryde, New South Wales 2113
Australia

The articles in the first three parts of this book reflect current thinking and practice world-wide in the area of out-of-school science activities. They present a comprehensive overview of the main issues and problems especially focusing on the purpose and aims of such activities and on aspects of implementation. This last part of the book attempts to synthesize some of these key ideas and trends and to assess future prospects.

The problem of definition

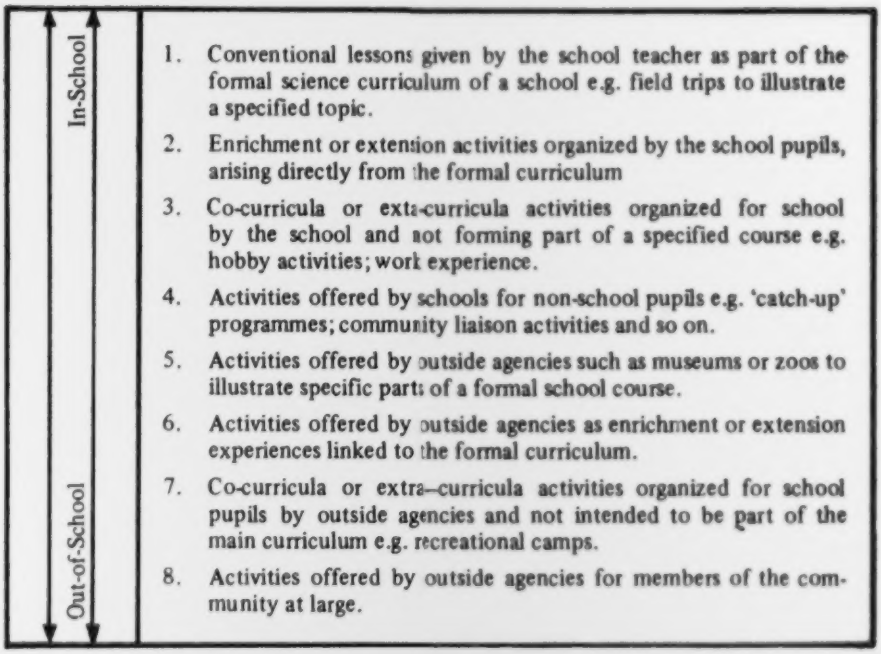
In this book different authors have taken different views of what is meant by the phrase "out-of-school activities". One approach to seeking a definition is to note what is implied in discussions by Michael Atchia, A. N. Rao, Winston King and others – that there is a type of continuum from an entirely "in-school" focus at one end to a fully "out-of-school" orientation at the other and the location of any particular activity on this continuum is determined by factors such as (i) for whom the activity is designed (ii) by whom it is organized and presented and (iii) for what purpose it is intended. This concept is illustrated in the following diagram.

Some authors such as M. Subbarini are concerned more with the 'in-school' end of the continuum while others such as Michael Atchia have a stronger 'non-school' focus. But whichever part of the continuum is addressed, it is clear that most authors are sensitive to the dangers of an artificial dichotomy between *school* and *non-school*. Throughout this book there is an almost universal plea for school and community to move forward together and for science teaching to have both an information and a societal function.

Peter Kelly's introductory paper sets the stage by discussing the necessary 'knowledge' base of formal science courses in schools and the 'issue' base which emerges only when scientific knowledge is applied to the solution of socially meaningful problems. He sums up the position well by his comment that the main aim of science teaching is "to produce a society enlightened about the nature of science, knowledgeable about its major ideas, with understanding about its technological value and its social and personal implications, and actively committed to the idea that the affairs of science are inextricably entwined with that of society".

It is this view too that is developed in some detail in the article by Bill Mayer. He argues strongly that "in-school" versus "out-of-school" is an artificial dichotomy. He points out that schooling is part of living and that science teaching should make living more meaningful and rational, free from the constraints of superstition, prejudice and

A CONTINUUM OF SCIENCE ACTIVITIES FROM IN-SCHOOL TO OUT-OF-SCHOOL


In-School
Out-of-School
1. Conventional lessons given by the school teacher as part of the formal science curriculum of a school e.g. field trips to illustrate a specified topic.
2. Enrichment or extension activities organized by the school pupils, arising directly from the formal curriculum
3. Co-curricula or extra-curricula activities organized for school by the school and not forming part of a specified course e.g. hobby activities; work experience.
4. Activities offered by schools for non-school pupils e.g. 'catch-up' programmes; community liaison activities and so on.
5. Activities offered by outside agencies such as museums or zoos to illustrate specific parts of a formal school course.
6. Activities offered by outside agencies as enrichment or extension experiences linked to the formal curriculum.
7. Co-curricula or extra-curricula activities organized for school pupils by outside agencies and not intended to be part of the main curriculum e.g. recreational camps.
8. Activities offered by outside agencies for members of the community at large.

bias. This theme is taken up again and again throughout the book – but especially in articles by Kozo Imahori, Elias Baydoun, Gerhard Schaefer and Winston King.

Following from this argument, therefore, the definition of out-of-school activities effectively reduces to a philosophical viewpoint. This viewpoint states that school and community are one, and that "out-of-school" is merely a convenient conventional phrase to describe those activities which aim to establish the social relevance of a concept, value or skill.

In the real world, however, definitions are rarely so simple and a purely *physical* meaning of the term also must be considered. It is this: that out-of-school activities are those activities which occur outside the physical limits of the school – some authors even considering activities held in the school grounds to fit the definition. Peter Kelly implies, however, that these 'social' and 'physical' definitions interact because as activities move from outside the formal classroom into the community they inevitably become less 'knowledge-based' and more 'issue-based'.

There is a further complication. As shown in the continuum idea, out-of-school activities can be organized by the school or by other agencies for school pupils or by other agencies for the community at large. A definition of out-of-school activities must accommodate this broad spectrum from the formal activities of formal educational institutions, including 'schools' in the narrow sense of primary and secondary schools, through to totally informal activities of groups and individuals in the total community. This latter aspect has been considered to a degree in this book by Michael Atchia, Kozo Imahori and others but inevitably the phrase "Out-of-School" implies by its very wording a relationship with the formal school system. Most authors, therefore, have tended to

limit discussion to those out-of-school activities organized by or for schools, and this narrower interpretation, while almost inevitable, has tended to direct the attention of most authors in this book away from issues of continuing education and life-long learning which surely must represent the points of educational focus in the coming decades. This aspect will be further considered below in discussing the purpose of out-of-school activities.

In summary, therefore, a definition of out-of-school science which accommodates the views of most authors of this book is difficult to achieve. A statement which includes most viewpoints could perhaps be that *out-of-school science activities are those activities which stress both the knowledge base and social applications and relevance of science; which are usually held away from the school site; which are designed for school pupils or other members of the community, and which may be sponsored by school or non-school agencies.* If adopting this type of statement, however, great care must be taken to avoid the danger of dichotomizing 'in-school' and 'out-of-school' as opposed bipolar concepts, so setting school and community apart. In fact the very term "out-of-school" is partly anomalous because the idea that lies behind the phrase is as implied in the article by Gerhard Schaefer, a concern for "internalizing" community and societal needs into the main stream educational process – both in schools and in the informal educational activities of the community at large.

Types of out-of-school science activities

The types of activities given as examples of out-of-school science by the author team are widely varied, but they do have several common features. In the first place, to fit the definition, they are usually organized for school pupils or others, away from a school site. Secondly, they are almost always activity-based, involving learners in direct experience of some object or phenomenon or situation. Thirdly, in the main, they involve experiences that cannot be easily gained from a conventional classroom situation. Fourthly, they are usually problem or inquiry oriented, focusing on the application of science to the solution of a socially relevant issue or problem.

These features tend to characterize out-of-school work whether as an element of a formal institutional programme; as part of a programme of an outside agency, or as part of an informal community activity.

Several types of out-of-school science activities can be identified from the case studies and examples described in Parts II and III – and almost all share the four characteristics outlined above.

A predominant type involves environmental, ecological or field studies usually in field 'centres', ecological reserves, or other types of natural areas. These "field" experiences frequently involve ecological surveys or natural history observations and are generally, but by no means always, determined by the dictates of a formal curriculum. A related type of activity is a visit to a zoo, museum, botanic garden, or industrial site for specific lessons presented either by the regular classroom teacher or by staff of the institution being visited. These two types of activities are little more than extensions of the conventional classroom, but form a definite and frequently most common part of the out-of-school repertoire.

Another type of out-of-school category that has a strong link with main stream internal activities includes those recreational, sporting and social activities held away from school which involve a measure of formal substantive science. These include orienteering, bush walking, fitness adventures, astronomy activities, camping, forestry and agriculture activities and so on.

A further type emerges more from the extra or co-curricula 'voluntary' activities of

a formal educational institution such as a primary or secondary school. Such activities are frequently organized from within the school by science clubs and science societies and from outside by community agencies such as professional associations; special interest groups; museums; commercial firms and so on. Such activities can lead to science competitions; school science research projects; science fairs; poster competitions; community projects and many other worthwhile outcomes.

An even more loosely linked type of activity reported by some, is the area of work experience. There is an increasing trend world-wide to facilitate the difficult transition from school to work by giving students some sort of job experience while they are still at school. This is frequently organized by arranging for two or three weeks of the school year to be spent in some supervised employment. This type of activity is, however, frequently somewhat *ad hoc* and does not have all characteristics of a true out-of-school learning experience as outlined above. Nevertheless work experience activities have the potential for providing highly relevant out-of-school science experiences provided they can be monitored and integrated into a total educational sequence.

Several authors mentioned the significance of the mass media in out-of-school science activities, and there is no doubt they do have a major role both formally and informally – see for example the article by Bill Mayer. In the first place, as argued by Mayer, the mass media frequently have soundly scientifically based programmes, such as the Carl Sagan *Comsos* series, which help to counter anti-acience and pseudo-science trends in society. School pupils should be encouraged to study such programmes which could be "built-in" to the normal scheduled curriculum. In the second place the mass media have important roles to play in developing the critical, problem solving and observational skills of pupils. Teachers can use advertisements, general news reports, documentaries and so on to train pupils in objective analysis and the detection of bias, false evidence, prejudice, false argument, the distinction between 'fact' and 'theory' and so on. There are other roles, of course, for the mass media. They can be utilized for programmes of "distance" education, for main-stream elements of a formal programme, to provide enrichment or co-curricula elements or as part of a community-based educational activity for, say, the improvement of basic education, scientific literacy and so on.

Another type of out-of-school science activity is the investigation by a class of science-oriented social community problems such as the causes of pollution of a local river; or the possible effect of a proposed garbage disposal unit on a specified location and so on. Basically these types of activities are case studies of the environmental impact of an existing or proposed community activity. They are usually difficult and time consuming to organize but certainly stress the *issues* of science in society. When effectively organized they involve close interaction between pupil, teacher, parents and defined categories of the community.

So far, the types of activities described above have been those originating in a school or other agency such as a museum, for school students. But out-of-school science must, by definition, also include those science-oriented activities mounted by schools or other agencies for the community at large. These can range from straight-forward programmes for parents through to highly organized adult education activities such as environmental impact studies; community planning programmes or scientific research activities organized by adult education groups in areas such as natural history, astronomy and engineering.

A special aspect of the last mentioned type of activity is the existence in a community of science-type facilities such as those available in Singapore and described in the article by A N Rao in Part III of this book. These include botanic gardens, zoos, museums, libraries, research institutes, and so on, which members of the public may visit informally, frequently alone or in family groups. These usually offer "thematic displays" as well as

having general resources or permanent displays or collections. They make a direct and highly significant contribution to out-of-school science.

Finally, there must be considered the complex network of totally informal learning that occurs in the community at large, much of which is science based. This type of out-of-school activity includes staff development programmes in industry and government; self learning activities by individuals; programmes by adult education units and community centres; activities by voluntary associations and special interest groups and so on. These types of activities are the backbone of what has come to be seen as a "learning society" – a society committed to what Unesco terms "lifelong learning" by all citizens. Unfortunately, few societies today have reached this goal on a fully national level, but many sub-national communities have become true learning societies – for example certain sectors of large urban centres such as London, Sydney or New York. Science based activities form an important strand in this total pattern.

Clearly the types of activities reviewed in this section, parallel the continuum mentioned earlier, from those with a strong in-school correlation at one end through those involving school – community interaction at a mid point to those with a purely social or community basis or orientation at the other end. In all types, however, science education is perceived as something more than formal classroom lessons. It is seen as having an important role in conveying messages of importance and significance to the society as a whole.

Another point emerging from this survey of types of out-of-school science activity is that the continuum reflects an increased sophistication in purpose and goals. All points along the continuum interact. School based out-of-school science increases scientific literacy and an understanding of the social roles of science, and that in turn sensitises the learner to accept responsibility for his or her own learning not only at school but throughout life. This issue is the dominant theme, for example, of the article by Michael Atchia in Part II of this book. Formal institutionalized learning merges into informal non-institutionalized learning and paves the way for a commitment to continuing "life-long" education and the evolution of the learning society. Out-of-school activities thus form a "bridge" that facilitates transfer from schooling to life-long learning. This issue is, of course, at the heart of any consideration of the purpose of out-of-school science and that aspect will be discussed further below.

The purpose of out-of-school science

The authors of this book have claimed a great deal for out-of-school science. Almost all see it to be a major factor in fostering development of balanced human personalities and healthy purposive communities. This claim comes from an awareness that a bridge is needed between formal schooling and informal learning in the community at large and that out-of-school activities as here defined form a key element in such a bridge. Possibly the strongest claims for out-of-school science come from Japan (see the article by Kozo Imahori in Part III). The hypothesis is advanced that modern Japanese society has become alienated from nature and that the sudden advent of technology has brought about a cultural dissonance leading to outbreaks of violence; a stress on examination success; a lack of empathy with others and a pursuit of naked materialism. Out-of-school science, especially of the type that encourages empathy with nature, will help return society to the humanity and social harmony of the past. This is to be achieved by developing social skills and co-operative behaviour through sharing in out-of-school experiences – especially in-field work and the exploration of nature in natural history centres, national parks and wilderness areas. Similar sentiments are expressed by Siew Cheong in her article on out-of-school science in Malaysia. (in Part III). She sees out-of-school as contributing to

the development of co-operation, sharing and compassion in the organization and experience of activities held away from the formal classroom.

This assessment of the purpose of out-of-school science is also reflected to a degree in the analysis by Gerhard Schaefer of the history of out-of-school science in Germany since 1900 (see his article in Part III). Schaefer puts the emphasis on the important role of out-of-school science, especially field work and direct experience with nature, in the integration of willpower and sensory perception in a balanced personality. Somewhat in contrast to the situation in Japan he sees this as a relatively new movement and tends to blame the past neglect of out-of-school science on social and political pressures that tended to encourage interaction with nature for the wrong reasons and at the wrong level of intellectualism. He sees earlier movements such as the youth movement of the first decades of the century and the later Hitler Youth activities that extolled nature without a true scientific explanation of its basis as animistic and forms of unreasoned biologism. Only through development of a true scientific understanding of nature can out-of-school science experiences lead to a meaningful coherent personality. Fred Gornall in his account of School Camps endorses this view, stressing that the social, academic and recreational aspects of, say, a school camp experience, must be treated as an integrated whole if meaningful outcomes are to emerge.

An especially interesting extension of the thesis about cultural dissonance advanced by Kozo Imahori is the concept developed by Michael Atchia that the main purpose of out-of-school science in developing countries such as those in the African Region, is to compensate for the clash of two opposed cultures. These dissonant cultures are the basic traditional culture of the region and the 'modern' western scientific and technological culture superficially imposed by the colonial regimes of the nineteenth and twentieth centuries. According to this view the correct entry point for education is the community at large since it is sound practice to start from what is known – that is the local culture – and to build on that. This places an especially heavy responsibility on out-of-school science.

Other authors have assigned a more specific role to out-of-school science in as much as they see the general community as being in need of improved scientific literacy. M. Subbarini limits the argument to improving community understanding of the methods of science in Kuwait through school-based out-of-school science. Others such as Peter Kelly and Elias Baydoun see the improvement of scientific literacy as a key step towards the application of science in the consideration of socially relevant issues. A key purpose for out-of-school science in Jordan, argues Elias Baydoun, is to facilitate development of social skills and to encourage scientific thinking and the application of the scientific method in the solution of social problems.

This view is also presented and argued in depth by Bill Mayer who not only recognizes the importance of out-of-school science in raising standards of scientific literacy in the community, but also sees a cultural purpose in overcoming irrational, unscientific and anti-intellectual forces in affluent societies such as those of the United States. Bill Mayer strongly implies that the school should prepare for out-of-school life-experiences both directly and indirectly by sensitizing all citizens to the rationality of science through increasing what he terms "attentiveness" to science. For him the purpose of out-of-school science is the same as the purpose of science education *per se* since he argues that in-school and out-of-school is an artificial and, in fact, potentially dangerous dichotomy tending to separate thinking about schooling from thinking about the community at large.

Winston King, in his article on the West Indies, sees the purpose of out-of-school science, at least in part, as improving general levels of scientific literacy with the view of

contributing to national development, the wiser use of the environment and improved and more effective use of recreational opportunities. King also sees that an especially important purpose for out-of-school science is to combat superstition, prejudice and irrational fear which he implies are widespread in West Indian society.

Most authors, therefore, see out-of-school science as contributing in a meaningful way to the healthy evolution of society. Some as already mentioned, however, also see that a key purpose for out-of-school science is to develop the individual personality and to increase the range of educational opportunities for individual growth. Gerhard Schaefer and Kozo Imahori in particular stress that *both* social evolution and individual personal development are involved and that these closely interact. Other authors touch on more specific aspects such as to encourage wise use of leisure (A. N. Rao) or to help overcome prejudice against manual work (W. King).

Most authors also see somewhat less demanding roles for out-of-school science – more in terms of increasing the variety of presentation methods and enlarging the range of instructional options. These types of roles are of considerable importance in effective curriculum design and should not be overlooked in any consideration of the purpose of out-of-school science.

The various arguments and viewpoints presented by the author-team tend to come down to seeing a central purpose for out-of-school science in terms of life-long learning. The ultimate purpose of out-of-school science, as previously argued, must surely be to help all citizens accept responsibility for learning throughout life and to contribute to the development of the skills required for this.

Aims and objectives

The translation of concepts of purpose into practical statements of aim and of aims into operational objectives is clearly society – specific, but nevertheless certain commonalities emerge from a comparative analysis. Several members of the author-team put forward systematic lists of aims for out-of-school science. Some of these are reproduced in tabulated form below. These examples are mainly for out-of-school activities organized by a school system for its own pupils.

General Aims : Meyer

1. Extend pupils horizon and experiences by involving them in a wider range of activities than they would encounter at home or school;
2. make schooling more relevant to the real world by involving pupils in activities on site in the community and in the natural environment;
3. train pupils in the skills of solving problems in real life settings through processes such as observation, record keeping, analysis, interpretation and evaluation;
4. introduce pupils to features of his or her local environment, natural and cultural, both as it is in the present and as it was in the past;
5. develop in pupils an understanding of how mankind is managing resources both in terms of effective use and misuse;
6. develop the social and physical skills of pupils in natural and cultural settings away from the contrived social climate of the school;
7. develop in pupils the ability to make meaningful decisions about the quality of the environment and on a desired life style for themselves personally and the community at large;

8. develop positive attitudes and to hold appropriate values about the natural and man-made environment;
9. develop both understanding and appreciation of an individual's roles in both natural and man-made environments for the maintenance of a satisfactory quality of life;
10. develop in pupils the point of view that the environment, be it natural bushland, an urban setting, the home, the school, the place of employment or whatever; is a resource for providing opportunities for personal growth development.

Aims for Jordan : Baydoun

1. Enrichment of science education programmes;
2. perception and implementation of scientific concepts;
3. the study of ecosystems, with special stress on environmental problems;
4. attainment of social skills;
5. encouraging students to think scientifically and to apply the scientific method to social problems.

Aims for Malaysia : Cheong

1. Develop environmental awareness so as to provide students with a better understanding of their surroundings and of the relationship of life with them;
2. provide students with some knowledge and understanding of the environment, natural as well as man-made, through involvement in investigations in real life situations;
3. develop understanding of the scientific basis of problems and issues in the community and the impact of these on the well being of the physical and human environments;
4. develop a deeper understanding of the practical application of science, such as in industries, agriculture and medicine, for social and national development;
5. develop higher cognitive skills in solving problems and making decisions through the use of scientific processes in real life situations;
6. extend students' scientific knowledge and experiences in aspects of science and technology which are unavailable within the laboratory and school;
7. develop healthy attitudes and values toward the use and abuse of environmental resources and to appreciate the contributions of these for the quality of life;
8. develop desirable social behaviours – co-operation, sharing, compassion, among students in outside settings;
9. develop a greater motivation and interest in science and scientific activity.

Aims for the West Indies : King

1. To ease the pressure on the school curriculum;
2. to help focus on the community and environment;

3. to help cultivate desirable attitudes towards science;
4. to help in the general education of the community;
5. to encourage the use of scientific method to search for problems;
6. to foster scientific literacy;
7. to provide some 'answers' to community and environmental problems;
8. to help eradicate the myth that education is within school walls only – towards non-institution-based education;
9. to produce a heightened awareness of importance of the environment for development and recreation;
10. to help remove the stigma attached to manual work and work of a non-academic type;
11. to help eliminate the belief that strange phenomena are magical, and to stamp out superstition.

These representative statements from four markedly contrasting cultures share several elements: concern for the quality of life; concern for maintaining the integrity of the natural environment; concern for establishing the social relevance of science; concern for strengthening links between school and community; concern for *improving scientific* literacy; concern for improving problem-solving skills; concern for improving social behaviour; and concern for encouraging wider use of educational opportunities and resources in the world away from the school.

How programmes and specific curricula operationalize these and related issues depends on factors such as educational level; source of the programme; resources available and the specific needs of the community concerned. Further the links between overt or covertly stated concepts of purpose, general aims and programme objectives are rarely one-to-one and are usually somewhat diffuse. Nevertheless some clear-cut directional paths do emerge. The commonly stated purpose for out-of-school science that it should be concerned with improvements in scientific literacy is frequently expressed in aims such as:

- develop a knowledge and understanding of the main concepts of science
- develop an understanding of the processes of science.
- describe the scientific principles involved in cleaning a polluted stream
- state hypotheses to explain the origin of the pollution.

. . . . and so on.

The directional chain from purpose to objective is more difficult to trace when the concept of purpose is expressed in very general terms such as compensation for the clash between traditional and colonial cultures in a developing country (Atchia); or to overcome social tensions arising from an alienation from nature (Imahori). Such statements however, *can* be operationalized. Take the former as an example. Aims deriving from the purpose of compensating for cultural dissonance could perhaps be expressed as follows:

- develop an awareness of the scientific basis of traditional practices and beliefs
- develop an understanding that scientific principles and processes can solve day-to-day problems of a community following a traditional way of life.

. . . . and so on.

Objectives arising from such aims may perhaps include the following (using the example given in the article by Michael Atchia):

- make a simple refrigerator following local traditional methods
- explain how the refrigerator works in terms of basic principles of physics.

. . . . and so on.

One of the problems of out-of-school science in many educational systems is that such directional chains from purpose to aims to objectives have not been sufficiently articulated. This has tended to lead to *ad hoc* programmes, unco-ordinated and lacking in clear focus. It is not surprising, therefore, that many members of our author-team complain of lack of integration between out-of-school activities and the mainstream curriculum, and that such activities often appear as something "added on" with less status than the formal elements of a school curriculum. This implies that curriculum workers in both the formal and informal sectors should address the question of the purposes, aims and objectives of out-of-school science with more precision.

Content and methods of out-of-school science

The selection of content for out-of-school science is of course, as varied as the types of possible activities but certain general criteria can be established for selection of appropriate scientific principles. Not all criteria may be relevant in all circumstances but the following list is representative.

Criteria for out-of-school science content:–

1. Concepts and principles not easily demonstrated within a traditional classroom.
2. Principles which lead easily to a consideration of socially relevant issues.
3. Principles which form a basis for problem-solving activities.
4. Principles and topics which lend themselves to participatory learning.
5. Concepts which can be illustrated by socially oriented methods of teaching such as small group work; simulation techniques; dramatic and semi-dramatic methods and experiential learning.
6. Concepts which can be applied in the rational explanation of traditional cultural practices and behaviours.
7. Concepts which illustrate the interaction between the human species and the natural environment.
8. Principles and concepts which impinge on social problems requiring values clarification.
9. Principles and concepts that lend themselves to a degree of individual interpretation and explanation.
10. Principles which would encourage pupils to accept the challenge of controlling their own autonomous learning.

Methods of teaching follow logically from the objectives of a given programme and from the content selected by criteria such as those listed above. There are some methods, however, which are generally more appropriate and relevant if the social significance of out-of-school science is to be kept in central focus.

One method of special importance in out-of-school science is, of course, field work. But if field work is to achieve more than scientific knowledge and understanding by dealing with issues of social relevance, then it must involve more than classical ecological surveys or observations of animals and plants in their natural habitats. These experiences

must be tied to other activities involving critical evaluation. An especially suitable approach is to involve pupils in one or more types of small group activity – this could involve guided or leaderless discussion; syndicate discussion; brainstorming; case-study analysis; formal debate; nominal group (voting) procedures to determine priorities; mirror groups to appraise one-another's viewpoints and so on. Only by testing out ideas against the ideas of others in a group situation will learners develop and clarify values.

Out-of-school science investigations can also have a different process focus according to the objective involved. Sometimes the emphasis can be on experimental design and application; sometimes the focus can be on planning; at other times it can be on the development of a resource or a facility (e.g. building a nature trail); sometimes the approach can be analytical that is, say, identifying elements in a situation, and at other times the stress can be on evaluative judgement. By stressing different aspects of processing information learners develop a transferable skill which can be applied to the solution of socially relevant problems.

A neglected category of methods which can be applied very successfully in out-of-school settings – especially in camps and extended "on tour" excursions and visits – involves simulations, dramatic and semi-dramatic techniques. The simplest and best known of these is role-play and it is an especially helpful method for extending the experience beyond scientific knowledge for its own sake towards a consideration of related social issues. Discussion occurs in a fail-safe "simulated" non-threatening situation which allows a free exploration of points of view and a comparative analysis of values. Sociodrama and creative drama are also very useful techniques. Sociodrama involves a group in reading and analysing a short scripted conversation stressing human interactions and relationships. Participants are not allowed to move about but must simply read their parts, using feeling and emotion to portray their roles. Special techniques such as use of "doubles" (a simultaneous reader), "sympathisers" and "antagonists" (one of each assigned to each character in the script) and objective observers, can ensure that all members of the group are involved. Creative drama is a more open form of simulation. Rather than just reading a script, participants play interactive person-to-person games (e.g. to devise a group story with each participant adding only *one* word at a time). This technique can be very powerful in terms of subject matter content but more significantly it develops generally transferable skills required for good interpersonal relations; co-operative decision making; leadership; communication skills and so on. Inter-personal games are also especially useful in out-of-school settings. Groups follow through a structured set of activities according to a set of rules, usually in teams. The aim is usually to explore the social consequences of certain actions or policies. These in turn must have arisen from a science-based study in an out-of-school setting. Simulated case-studies; board games; and "in-tray" or "in-basket" methods should be considered within this category. The latter technique is especially useful. It involves individuals or groups reading the in-tray correspondence of a particular person who must make a decision on a critical issue (say a scientist, a government minister or a local businessman). Problems are explored and resolved in a social context.

Something has been said earlier about work experience and experiential learning; and this is in fact, a technique of out-of-school teaching that is highly relevant to the present discussion. It could be approached in a number of ways. The most obvious but perhaps least effective is to utilize visits and excursions to various centres in the community to observe and analyze work situations. Such visits can be built into a conventional programme but to be maximally effective must be carefully structured and be linked strongly to the main-stream learning sequence. Direct work experience for say school pupils or students in other educational institutions can be also achieved by temporary exchanges or secondments between schools, institutions, branches or agencies and potential em-

ployers. These arrangements must be carefully structured so that definite outcomes are sought. Observation schedules, report forms and other devices can be used to direct the learners observations. The ultimate technique, of course, is to develop opportunities for actual employment, perhaps "sandwiched" into a conventional programme or else as the main focus for an on-job training sequence. Task and job analysis can identify skills to be developed and techniques can be applied to help 'employees' diagnoze their "on job" weaknesses and strengths and to undertake job-improvement programmes.

If, as has been claimed, out-of-school science is to contribute to autonomy of learning with individuals accepting responsibility for their own learning ready to participate in a learning society, then the whole range of methods for independent self-paced learning becomes especially relevant. Programmed resources; independent reading; computer assisted instruction; audio-tutorials; modular instruction and the Keller Plan or the Personalized System of Instruction are well known systems, all of which have a place in out-of-school science. They encourage independence and cater for certain aspects of individuality. The audio-tutorial is of special significance since programmed audio-sequences and activities can be organized for field work; visits to industry; museum and zoo activities and so on.

In concluding this section it is important to again stress that since the purpose, aims and objectives of out-of-school science are perceived by all members of the author-team to be concerned with social applications and indeed with social reconstruction, the methods of teaching employed must be appropriate. In many respects methods of teaching, rightly or wrongly, which have been perceived in the past to be the exclusive province of the social science teacher and in particular, of personal development programmes, should now become part of the teaching repertoire of the science educator. It is especially important that these be used in out-of-school experiences in order to strengthen the idea so powerfully argued by Bill Mayer that in-school and out-of-school are merely two aspects of the one process.

Organizational and management issues

For out-of-school science activities to be maximally effective a number of organizational and administrative aspects need careful attention. Many of these were raised by the author-team. In this section a few of the key issues are addressed with most stress being placed on out-of-school activities organized by schools for their own pupils. The section concludes, however, with a few comments on special organizational and management issues associated with out-of-school activities presented by the informal educational sector of the community.

One aspect of considerable sensitivity and concern for schools is how to timetable out-of-school activities. There are two elements to consider. The first is the amount of proportional time available for science as a whole and the second is how to find the "extra" time needed to journey away from the school. In regard to the first it is true that if science is given only a small proportion of the contact hours each week then it is especially difficult to organize out-of-school experiences. Science teachers should perhaps help in formulating new policies in this regard but even if they fail to gain more contact time for science something can be done. One way, of course, is to do what Bill Mayer advocates – bring out-of-school experiences more frequently into the conventional classroom. Another technique is to make use of the school grounds and the immediate environs of the school. Finding longer blocks of time for more extended visits and activities away from the school site is a perennial problem and many approaches have been tried with varying degrees of success. Trade-off in "periods" with other teachers is a very basic approach. Block-times per term or per month for the whole school to be involved is another proven technique. And then, of course, there are the "after-school"

hours: late afternoon (especially in the summer months in northern latitudes); weekends, and vacations. Finding time for out-of-school work does take considerable effort and patience and requires a degree of commitment on the part of the teacher.

A related concern is the integration of out-of-school activities with the main-stream teaching sequence. Several authors noted that this aspect is frequently poorly organized and out-of-school experiences often occur on an *ad hoc* basis and as something "extra" rather than as part of a logical structured teaching programme. This problem is somewhat aggravated when host agencies such as museums, zoos, industrial installations and so on impose their own sequencing, offering specified topics on dates which do not correlate with the school programme. These problems can only be overcome by long term forward programme design and by adherence to the logical rules of subject matter sequencing.

An important management aspect is to ensure that all resources required for out-of-school science are readily available. Not the least of these, of course, is access to a suitable site and if the objectives involve study of a natural or wilderness area this problem is especially difficult in highly urbanized communities. The article by Kozo Imahori in Part III shows how critical is this problem in urbanized Japan. Transport must be planned well in advance and costs must be kept within the budget. Some authors such as Fred Gornall have mentioned low cost transport systems such as parent's car convoys, or the use of bicycles. Another important resource is personnel. Apart from classroom teachers themselves, teaching support can be frequently obtained from especially trained staff in museums, zoos, botanic gardens, wild-life sanctuaries, indust ial sites and so on. Parents and interested citizens also can frequently join a team as teachers' aides, especially when there is a recreational or purely social element involved as at a school camp – see the article in Part III by Fred Gornall for example. Physical resources such as learning materials, collecting gear, experimental apparatus, cameras, clip-boards and the like must be organized well ahead and monitored rather more closely than in conventional classroom situations.

Supervision during out-of-school activities is an important factor and the safety, well-being and general welfare of the students is a major concern. Teachers' aides have a major role to play in this regard, but safety rules, put forward in a positive not restrictive manner, must be clear to all.

Individual "lessons" in out-of-school situations must be carefully planned to ensure retention of the special wonder, enthusiasm and commitment that such situations generally engender. As Fred Gornall explains so clearly, in his article on school camps in Canada, direct experience and interaction with phenomena is more important than talk. Starting an out-of-school experience in a formal classroom or by using formal classroom techniques should be avoided. Lesson notes should consist of little more than instructions for activities and not contain thousands of words of information which distract learners from observing or interacting with the phenomenon to be studied.

Out-of-school science experiences especially lend themselves to an individualized approach and this aspect is a very important issue in their organization. Individualized learning is different from independent or self-paced learning although it may include some self-paced activities. By individualized instruction is meant that the needs of each individual learner are diagnozed, learning pathways are prescribed leading to the achievement of negotiated objectives, and assessment of achievement is undertaken at regular intervals. Usually the work is organized into modules or units and the programme is frequently based on a mastery approach. The learner and the teacher sometimes sign a contract for the organization and completion of each unit of work. Individualized learning does not always involve the learner in working alone. A wide range of instructional options is usually available and the learner combines work in large groups and in small

groups with self-paced activities according to his or her personal need and according to the nature of the objectives to be achieved.

The "open" nature of out-of-school experiences make them especially suitable for the use of an individualized approach and this fits well with the idea of using them to develop individual responsibility for learning. This approach is very appropriate as the organizational basis for a school "weekend" excursion or a school camp. Individual contracts can be prescribed for the achievement of highly specific objectives and involving a wide variety of learning experiences.

Finally in this section on organization and management a few remarks need be added on programmes originating from the informal sector. This aspect can best be summarized by asking the six classical questions: Why? Who? How? When? Where? and What?

The issue of 'why' refers to the objectives of out-of-school science in the informal sector and these can be many and varied as the activities themselves: from staff development by an employer to community hobby groups and semi-formal 'catch-up' programmes. In each case the objectives should be carefully specified and activities planned to achieve these objectives. Informal out-of-school programmes are frequently organized by untrained teachers and it is especially important that help be available in the rudiments of instructional design.

The question 'who' refers both to organizers and to clients. For instance the organizer may be an adult education team and the clients may be interested adult members of the community and in such a case a major organizational issue is advertising and enrolment. It is essential that voluntary groups presenting out-of-school science activities base their programmes on an analysis of need – only then can they ensure that they will be "on target" in regard to the concerns of their client group. Other types of organizers, for example, firms offering "in-house" staff development programmes, may have a captive audience and must therefore be especially on guard to ensure genuine commitment and involvement.

'How' out-of-school science activities are organized by the informal sector is a complex issue. They may involve resources such as museums, zoos and so on which have structured programmes or they may start from first principles. It is important that the organizers have a good knowledge of the range of relevant resources available.

The 'when' issue is equally complex since some activities may be organized "on the job" or in the employer's time, while others may have to be fitted in to free-time after work such as weekends, evenings or vacations. A considerable degree of sensitivity is required to avoid over-committing members of the community and to ensure that the programme offered can be managed in the light of family, employment and other obligations.

The 'where' issue has already been mentioned in relation to zoos, museums and so on but it is probably realistic to state more generally that in the informal sector out-of-school science activities occur almost everywhere according to need. The more a community has evolved towards being a functioning "learning society" the more it will be aware of the opportunities for learning about science in almost every setting. The challenge is to utilize such opportunities to maximum advantage.

"What" should occur as the substance of out-of-school science in the informal sector depends on perceptions of purpose, aims and objectives and will vary from group to group and situation to situation. Once again the organizers of such activities would benefit by general training in aspects of instructional design.

The great challenge for the future will be to provide guidance, leadership and training in the informal sectors to ensure the effective organization and management of out-of-

school science experiences, in the evolution of a learning society.

Teacher education

As implied by all other authors and by the discussion in previous sections of the present article, out-of-school science activities require a range of teacher competencies which while overlapping with those of the conventional classroom, form a clear sub-set. Some of these are curriculum design competencies; others management and organizational; others supervisory and instructional and others empathetic and motivational. School teachers involved in out-of-school activities need to develop these competencies in both pre-service and in-service teacher education programmes, and community leaders in the informal sector need either to gain basic training in these areas or know where to seek help from trained personnel.

Several of our authors have commented on the need to build up teachers' confidence in the area of out-of-school science. Some, such as Kozo Imahori, suggest that there is a widespread lack of confidence due to a poor knowledge of substantive concepts and principles and of relevant details such as the identification of groups of plants and animals. He blames this on the neglect of systematics in current programmes of university and college biology. Perhaps, however, it is somewhat unrealistic to expect preservice programmes to anticipate *all* the knowledge required for out-of-school science. What should be emphasised are general processes. These processes are those involved in determining purpose, aims, objectives, content, methods, organization and so on as discussed above. More specific aspects could be left for inservice development at the appropriate time of need.

Inservice education for out-of-school science could take several forms. In his article in Part II the present author argues strongly that self evaluative checklists could be used to help science teachers identify those relevant competencies that may need further development through inservice training. It is argued that teachers who can teach others can surely teach themselves. They can utilize the wide range of training resources available in the community in general and the educational community in particular. If, for example, a teacher planning a natural history programme is uncertain about identification of relevant plant and animal groups, he or she may attend a short training course offered by a local museum, college or university or may undertake an appropriate course of observation and reading. In genuine learning societies teachers, just as all other citizens, are self-learning members of society and inservice development occurs as a part of lifelong self education. In societies where this stage has not yet evolved there is a greater obligation on the part of educational agencies to provide more structured programmes of training in the necessary competencies.

More structured forms of inservice training could involve "withdrawal courses" offered by various agencies concerned with out-of-school science. Some field centres, museums, zoos and so on provide special training courses to prepare teachers for the effective use of these resources. These types of "institution-specific" programmes have only limited value, however, as they tend to encourage a dependency on the skills of the specialized institutional staff.

A consultancy model for inservice education is generally more successful than a withdrawal model as it can more easily serve the needs of individual teachers in the context of their own schools. Consultants may be linked to regional offices of the employing Department of Education or to out-of-school science agencies in the community and could visit individual schools as part of school-focused inservice education, according to expressed need.

Another aspect of teacher education mentioned by several authors is the development

of appropriate learning materials for out-of-school science such as activity sheets; workbooks; text books; field-guides; species keys and so on, each accompanied by appropriate teachers' guides. The development of such materials is fully consistent with the idea of teachers accepting responsibility for their own inservice education. Some of these materials can be "teacher produced" and shared between schools; others may be produced by relevant agencies such as museums, zoos, game parks and so on; some may be centrally produced by the employing authority and some by commercial publishers. This type of development is important since it serves not only the formal sector but the informal sector as well.

Systematic forms of teacher education for the informal sector are very difficult to organize. Several aspects need attention. The first is to extend and improve facilities for relatively poorly trained members of the community at large to take leadership roles in the out-of-school science movement. This can be achieved by the production of useful resources as discussed above and by opening to a wider audience the inservice programmes originally designed for school teachers. Ideally, training institutes and agencies should mount "train the trainer" programmes so that the training has a 'pyramid' effect. Dissemination policies need careful attention if expertise is to spread throughout the informal educational sector. One important aspect of dissemination is to develop a programme to heighten awareness of opportunities for out-of-school science activities mass media; special publications; information centres; libraries and other resources should be used to the full. Centres and agencies which offer out-of-school activities should "reach-out" to the community using all possible techniques of communication.

The school system can also play a key role in training leaders in the informal sector. In the long term, of course, it is likely that many school graduates will become involved in such activities in later life. In the shorter term, however, the school can play an important role by working directly with parents. This can happen in two ways. Firstly by inviting participation by parents in out-of-school science activities organized for the pupils and secondly, by giving direct training to community groups interested in sponsoring out-of-school science – scouting and sporting groups; natural history clubs; bush-walking groups and so on.

Training of leaders in the informal sector is an especially important responsibility as it represents one of the few ways of combating the anti-scientism so prevalent in many societies – see for example the article by Bill Mayer in Part II.

Assessment of learning outcomes

Few of our authors have given detailed consideration to the problems of assessing learning outcomes from out-of-school science experiences. Part of the reason is that there are considerable methodological difficulties.

In the first place the experiences and hence the outcomes are very much more "open" than those in a conventional classroom. The activities can be relatively unstructured; extend over a longer period of time; involve a complex of interacting skills, and, in part at least, may be based on group rather than individual effort.

A second problem is that many of the expected outcomes are hard to measure by conventional test procedures. Aspects such as attitudinal variables; values clarification procedures and outcomes; the skills of interpersonal relations and social behaviour; the psychomotor skills involved in physical interaction with phenomena and so on are not always easy to assess.

One approach is to utilize the individualized contract idea. Each participant could have

a programme of activities prescribed involving some form of performance testing. Each element of the "prescribed" programme would need to be mastered and 'check-off' before proceeding to the next element.

The award of "grades" is generally inappropriate for out-of-school science activities, but if they form part of a formal examination curriculum, project reports and assignments could perhaps be graded in the usual way. Part of the problem of using this type of evidence is that the stress is on "product" not "process" and it is the latter that is of special importance in the out-of-school situation.

Much of the evidence for assessing outcomes of out-of-school activities must come from observing behaviour of individual participants. If the assessment needs to be formalized for some purpose then conventional types of observational rating schedules could be employed. Usually, however, assessment data collected from out-of-school experiences are not needed for formal grading purposes but for guidance and to facilitate learning, or as part of evidence needed for programme evaluation (see below).

Evaluation of out-of-school science programmes

Studies to evaluate the overall effectiveness of out-of-school science experience or to evaluate specific aspects such as optimal instructional design; organizational factors; costs and so on one all too rare. Many of the authors of this book have made strong claims for the role of out-of-school experience in personality development; in altering methods of thinking; in building attitudes; in social reconstruction; in over-coming cultural dissonance and so on. But the hard truth of the matter is that there is very little direct evidence that proves incontrovertibly that these gains occur. Part of the problem is related to the difficulties of assessment outline above – the open nature of the programmes and the difficulty of measuring relevant learning outcomes. This problem is more acute when even more immeasurable long term factors are involved such as overcoming alienation from nature or bridging the gap between two contrasted cultures. It may be said that the evidence for such outcomes is self evident but this may not be enough to satisfy senior government officials who require hard data before investing government funds in the development of out-of-school science.

Part of the problem disappears when it is recognized that in programme evaluation usually group not individual data are all that are required for most purposes. This removes the need for very high orders of accuracy in individual measurements. Frequently qualitative descriptive reports give useful information and the overall behaviour of groups can be recorded in the form of descriptive profiles, based in part on observational ratings.

There is no space available in this book to review the general literature on programme evaluation. It is more relevant to point out here the urgent need for systematic studies in the area of out-of-school science. This urgency is apparent in programmes developed in both the formal and informal sectors but especially in the latter. The community at large needs to be convinced that these activities are worthwhile and will help in building both healthy, well-balanced individual personalities and a dynamic positively oriented society.

Future prospects

There is little doubt that out-of-school science, whether as part of formal schooling or as a community-based activity, will develop still further in the future. If our author-team is correct in their analysis of purpose, the community cannot afford to neglect this area if social evolution is to develop in a healthy way in the face of increased industrialization, greater community tensions due to population increases, increased competition for resources and so on. Since out-of-school science activities form a logical bridge between

schooling and informal community-wide education in an area needed to combat irrationality, bias, prejudice and illogical fears it has a critical social role.

The final message of this book, therefore, is to urge educators everywhere to give the highest priority to this sensitive and important area.

These priorities can be expressed within the formal sector by imaginative curriculum design, by developing flexible administrative procedures including a more relaxed approach to timetabling; by providing suitable sites for out-of-school science and further developing already existing facilities; by encouraging production of suitable learning materials; by reforming pre-service education; by increasing and diversifying facilities for inservice education; by helping to develop appropriate assessment procedures and by encouraging research into the effectiveness of out-of-school science programmes.

It is in the informal sector, however, where the most rapid developments are likely to occur. As more communities approach the ideal of the "learning society" so out-of-school science will be seen to be more and more important in combating anti-intellectualism; restoring contact and re-establishing empathy with nature; countering pseudoscience and irrationality and improving the skills of social decision-making. Educators everywhere should be aware of this likely future development and be planning now for new ways to encourage its growth. Maximum advantages should be seen in the home becoming a true learning centre equipped with computer and video-tape facilities; the strong community-centre movement should be utilized to the full; adult education agencies, libraries, special interest groups and voluntary agencies should be recruited in a campaign to put rational science in the centre of community thinking. Every avenue possible should be explored to ensure that the learning society of the future understands the nature and role of science in the evolution of a healthy society. Science teachers have a major responsibility in facilitating this important trend. Out-of-school science, as presented by the authors of this book is something very much more than an "extra" element in an already over-crowded formal curriculum. It is seen as a key to meaningful personal and social growth and as such should be nurtured and fostered in all communities.

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